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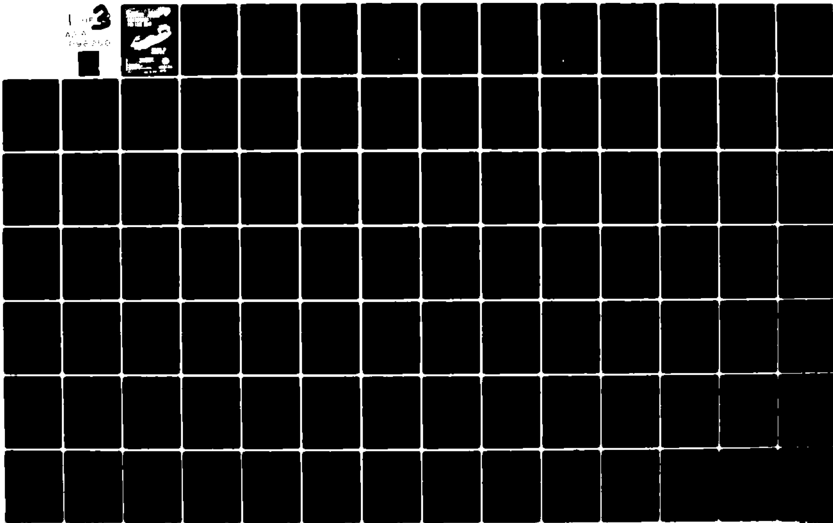

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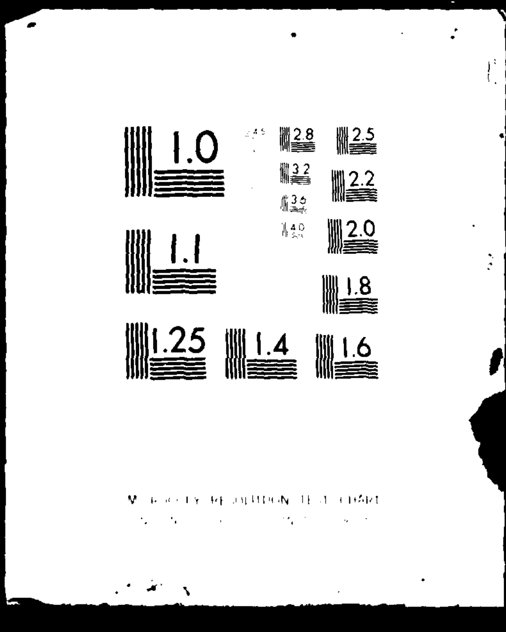

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This bibliography provides a reference that will be of aid to those individuals and/or agencies planning or initiating limnological research on Lake Erie and/or its tributaries. The bibliography is divided into five sections: biological, chemical, engineering, physical, and socio-economic. Pertinent information from both United States and Canada are documented. The papers cited in the annotated bibliography are located at Great Lakes Laboratory of the State University College at Buffalo unless otherwise noted.

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by

(10) Olga Krajnyak
Robert Sweeney

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I. INTRODUCTION

The purpose of this study, which was sponsored under Contract DACW 49-74-C-0102 from the Buffalo District of the U. S. Army Corps of Engineers, was to provide a reference that would be of aid to those individuals and/or agencies, planning or initiating limnological research on Lake Erie and/or its tributaries. The task was divided on the basis of disciplines into five (5) sections - biological, chemical, engineering, physical and socio-economic.

The holdings of libraries in both the United States and Canada were surveyed. Each pertinent reference was abstracted and examined with respect to the location(s) in which the study was conducted, parameters measured and techniques employed. In addition, the last known address of the agency or senior author was included to assist in locating the author if further communication is desired.

Unless otherwise noted, the papers cited in the annotated bibliography are located at the Great Lakes Laboratory of the State University College at Buffalo.

Due to limitations in time, we were unable to secure copies of all the references that may contain information relative to Lake Erie. These have been included in this paper.

II. SUBJECT INDEX

The number following each, refers to the number of the paper listed in Section III. Lake Erie was divided into twenty-one (21) regions, which are shown in Figure 1. The number twenty-two (22) refers to lake-wide studies; while numbers twenty-three (23) through thirty-four (34) concern specific tributaries to the lake. Thirty-five (35) concerns Sandusky Bay; while thirty-six (36) includes other tributaries.

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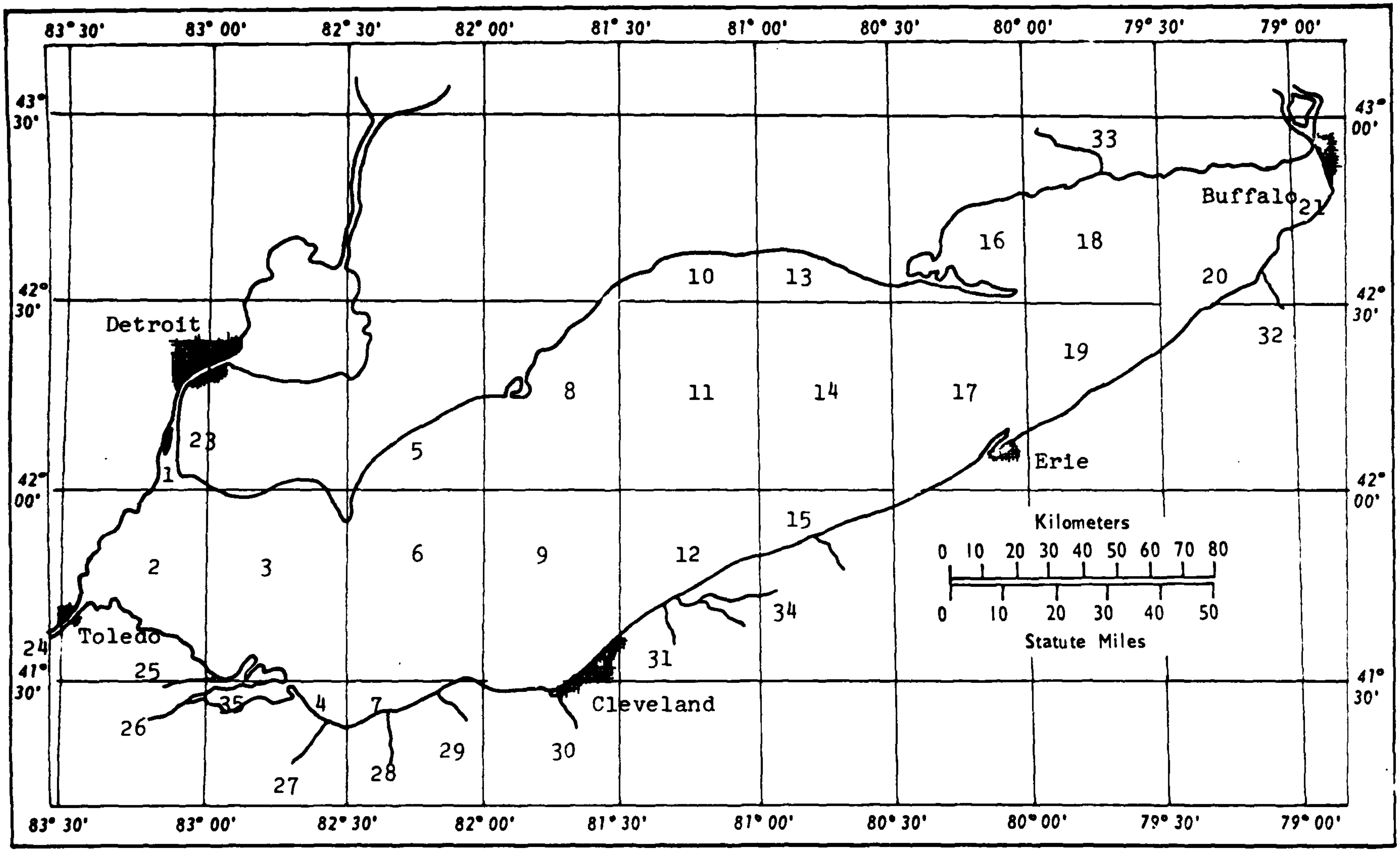
Figure 1 - MAP OF LAKE ERIE



22 = Lakewide 36 = Other Tributaries

KEY TO FIGURE 1

#	Numerical	#	Alphabetical
1 - 21	Quadrants in Lake Erie	29	Black River
22	Lakewide	32	Cattaraugus River
23	Detroit River	31	Chagrin River
24	Maumee River	30	Cuyahoga River
25	Portage River	23	Detroit River
26	Sandusky River	34	Grand River (Ohio)
27	Huron River	33	Grand River (Ontario)
28	Vermilion River	27	Huron River
29	Black River	22	Lakewide
30	Cuyahoga River	24	Maumee River
31	Chagrin River	25	Portage River
32	Cattaraugus River	35	Sandusky Bay
33	Grand River (Ontario)	26	Sandusky River
34	Grand River (Ohio)	28	Vermilion River
35	Sandusky Bay		
36	Other Tributaries		

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D. <u>Methods for Obtaining Samples for Analysis</u>

III. ABSTRACTS

Abbott, William L. - See: Clifford Risley, Jr., No. 277.

1. Abelson, Philip H. (Ed.). 1972. Great Lakes water treaty signed. Science. 176(4033):390.

A Great Lakes water treaty calls for dramatic reductions in the pollution of Lake Erie, Lake Ontario, and the international portion of the St. Lawrence Seaway, as well as for preventive maintenance to forestall the decline of Lakes Huron and Superior. Lake Michigan, which is encompassed by U. S. land, is omitted from the agreement.

Addis, James T. - See: N. Wilson Britt, No. 51.

Afghan, B. K. - See: P. D. Goulden, No. 137.

2. Ahlstrom, Elbert H. 1933. A quantitative study of rotatoria in Terwilliger's Pond, Put-in-Bay, Ohio. Ohio State Univ. Bull. 38(5): 36 p. Ohio Biol. Surv. Bull. 30. 6(1): 36 p.

Some of the chemical parameters which can affect biological systems were monitored during the study.

Alden, Jon C. - See: Daniel G. Bardarik, et al, No. 21.

Allen, Herbert E. - See: James R. Kramer, No. 199.

3. Allen, Herbert E. 1970. Chemical and biological quality of Lake Erie. In: Paul Kantz, Jr. (Ed.), The Environmental Problems of the Lake Erie Basin. John Carroll Univ. Lake Erie Conf. Carroll Business Bull. Spec. Issue. 10(1):17-21.

Many of the problems today are due to the inefficiency of waste treatments--the introduction of the inorganic nutrient materials, especially phosphorus and nitrogen. There are at least three conditions adverse to self-purification of natural waters: (1) excessive demands upon the system (too much material) will consume all the oxygen, (2) insufficient recovery time before using water downstream; without complete re-aeration the water will not return to its initial quality, (3) when non-degradable materials, including many synthetic and even toxic materials are added, the capability of the environment to cleanse itself is destroyed. NSQCD

4. Allen, Herbert E., W. R. Matson and K. H. Mancy. 1970. Trace metal characterization in aquatic environments by anodic stripping voltammetry. J. Water Poll. Control. pp. 573-581.

Perhaps the best method for trace metal characterization is anodic stripping voltammetry, which potentially is capable of performing in situ analysis of free and complexed metal ions in natural waters. Stripping voltammetry, in general, consists of a deposition step in which the desired component is deposited cathodically or anodically as a solid or an amalgam, and a stripping step (reverse electrolysis) in which the components are determined. Data is given for samples collected at the surface from the lower Rouge and Detroit Rivers, at the surface and bottom (15 m) from the Central Basin of Lake Erie 10 miles (16 km) northeast of Sandusky, Ohio.

Allender, Gerald C. - See: Thomas C. West, No. 370.

Anders, Hanns K. - See: Lester J. Walters Jr., et al, No. 361.

5. Anderson, Bertil G. 1944. The toxicity thresholds of various substances found in industrial wastes as determined by the use of Daphnia magna. Sewage Works J. 16(6):1156-1165.

The method for using daphnids as a test animal is described. As a method for the detection of toxic materials in trade waste, this is a relatively simple system. In testing substances, centrifuged Lake Erie water was used as a diluent, so that the various dilutions would represent as nearly as possible actual conditions. The threshold concentrations for immobilization of daphnids by 42 substances are given.

6. Anderson, Bertil G. 1945. The toxicity of DDT to Daphnia. Science. 102(2656):539.

The toxicity of known dilutions of DDT on the organism Daphnia magna was determined. Lake Erie water was used as diluent and control. Animals in concentrations of less than one part per billion survived as long as the controls.

7. Anderson, Bertil G. 1946. The toxicity thresholds of various sodium salts determined by the use of Daphnia magna. Sewage Works J. 18(1):82-87.

The aim of this paper is to present the threshold concentra-

tions of toxicity for thirty-eight sodium salts, anions of which occur in industrial wastes, when these were added to centrifuged Lake Erie water with Daphnia magna as the test animal. The experimental work on which the thresholds are based was carried out during the summer of 1944. The method used was that recently described by Anderson (1944) except that the immobilization time-concentration curves, from which the threshold concentrations were estimated, were constructed on the basis of forty-eight hours of observation rather than sixteen hours. In the experiments on which the present thresholds are based, eighty to one hundred per cent of the controls remained alive and active forty-eight hours or more. The toxicity thresholds for the thirty-eight sodium salts are given.

8. Anderson, Bertil G. 1948. The apparent thresholds of toxicity to Daphnia magna for chlorides of various metals when added to Lake Erie water. Trans. Am. Fish. Soc. 78:97-113.

The apparent threshold concentrations of toxicity to Daphnia magna are presented for 25 cations when added to Lake Erie water. Various factors such as the specific toxic actions of the cations, high acidities, excessive osmotic pressures, and precipitates operated to kill daphnids when the salts used were above the thresholds. When factors other than the specific toxic actions may have been responsible for death at threshold concentrations they are described. The thresholds presented are compared with those found by other investigators for Daphnia and other animals, especially fish. In general the Daphnia and related forms are more susceptible to cations than are fish.

Ecdysis is a critical period in the life of Daphnia, particularly in the presence of certain salts. Various explanations are advanced to account for this fact. Since daphnids are more susceptible at molting, it is essential that exposure periods be long enough to provide sufficient time for all the experimental animals to molt when threshold concentrations of toxicity are determined. This finding is expected to apply in toxicity experiments with other arthropods.

That the maximum safe concentrations in which wastes may be permitted to enter natural waters are not likely to exceed the threshold concentrations to Daphnia is discussed.

9. Anderson, D. V. and G. K. Rodgers. 1964. Lake Erie: Recent observations on some of its physical and

chemical properties. Ont. Dept. Lands and Forests. Res. Branch Rept. 54. Pt. 1. 65 p.

This report presents charts showing the temperature of Lake Erie in the summer of 1955, and in the summer and fall of 1960. Measurements of conductivity and of the concentration of oxygen are also given for 1960. Measurements of water temperature from 1955 to 1959 at Wheatley, Ontario are included as well.

10. Annett, C. S., M. P. Fadow, F. M. D'Itri and M. E. Stephenson. 1972. Mercury pollution and Lake Erie fishes. Mich. Acad. Sci. 4(3):325-337.

Various sources of mercury contribute to the mercury contamination of Lake Erie in the vicinity of the Raisin River. To assess their extent, 79 fish and 37 sediment samples collected from this area of Lake Erie were analyzed by flameless atomic spectrophotometric techniques. The average concentration of total mercury in the muscle tissue of several species of fish ranged from 0.06 to 1.7 ppm on a wet weight basis, and total mercury concentrations in the sediments ranged from 0.19 to 0.53 ppm on a dry weight basis.

Apidianakis, John C. - See: Paul J. Magno, et al, No. 220.

Applegate, Vernon C. - See: John F. Carr, et al, No. 84.

11. Archer, R. J., A. M. LaSala Jr. and J. C. Krammerer. 1968. Chemical quality of streams in the Erie-Niagara Basin, New York. Prepared for the Erie-Niagara Regional Water Resources Planning Board. Grand Island, N. Y. ENB-4: 104 p. + map.

Streams of Western New York vary their $CaCO_3$ concentrations between 100-200 ppm, sulfate concentrations from 20-60 ppm, and chloride 5-20 ppm. The dissolved mineral content of shallow ground water is the principal influence upon the chemical quality of the streams. The average dissolved mineral content is about 35 ppm; the higher concentrations, as much as 327 ppm, are attributed to industrial air pollution in the Buffalo area. Chemical analysis data from 700 samples collected during 1963-64 is included in the report.

12. Arnold, Dean E. 1969. Ecological decline of Lake Erie. N. Y. Fish and Game J. 16(1):27-45.

Changes in Lake Erie due to natural processes and the activ-

ities of man are discussed with respect to geology, hydrology, pollution, chemistry, plankton, benthos and fisheries.

13. Arnold, Dean E. 1971. Lake Erie: Alive but changing. In: Conservationist. December 1970-January. pp. 23-30, 36. Reprinted in: Univ. Mich. Great Lakes Res. Div. Collected Reprints. 3:272-283.

Any lake filling with sediment is indicative of aging. In Lake Erie, the sediment load is reflected in light penetration readings. Pollution in the form of silt, domestic sewage, and industrial wastes are responsible for the change in lake chemistry. Mercury has spread throughout the food chain of the Western Basin of Lake Erie. Thermal and radioactive pollution are hazards around power plants. All of the chemical constituents of the waters have increased during the past century. A serious environmental change is reflected in the dissolved oxygen level at the bottom. The three basins of Lake Erie differ: the Western is high in inorganic matter but too shallow to stratify; the Eastern is slightly stratified; while the Central Basin is stratified, resulting in oxygen depletion.

14. Arnold, Dean E. 1971. Thermal pollution, nuclear power, and the Great Lakes. In: Limnos. 2(1):20-24. Reprinted in: Univ. Mich. Great Lakes Res. Div. Collected Reprints. 3:129-139.

Both the proposed and the present power plants on Lake Erie are examined for their ability to raise the temperature of the surrounding waters. The discussion includes the known effects of increased temperatures on biological organisms. NSQCD

15. Arnold, Dean E. 1973. Environmental pollution: Effects on fish and game management. In: Richard D. Teague (Ed.), A Manual of Wildlife Conservation. Reprinted in: Univ. Mich. Great Lakes Res. Div. Collected Reprints. 4:1-4.

Research on environmental pollution as it affects fish and wildlife has been almost entirely limited to detection and proof of damage rather than to finding ways of reducing either the pollution or the damage. This paper concentrates on examples of environmental pollution which have influenced wildlife management, either by frustrating existing programs or by creating the necessity for new ones. NSQCD

Ayers, John C. - See: Charles F. Powers, et al, No. 271.

16. Ayers, John C. 1960. Status and programs. Univ. Mich. Great Lakes Res. Div. Proc. 3rd Conf. on Great Lakes Res. Pub. 4:61-74.

During 1959 a pilot study of the usefulness of collateral data in studies of Lake Erie was carried out. In this study, special effort was made to determine whether any of the collateral data sources were sufficiently representative of water conditions in the open lake to be used as stations at which to "watch" conditions of open-lake waters when there were no offshore cruises to provide such data directly. By comparisons of water data from shore sources with water data from offshore, it was possible to assess the representativeness of of the several data sources along the south shore of Lake Erie. The results indicate that not all the data sources are representative of open-lake water; the common reason for failure of representativeness is local runoff from tributary streams which reaches the intakes and is sampled.

As a part of a program of assembling the most complete possible background on the past environment in Lake Erie, a search for chemical analyses of Lake Erie water was made. Suitable data of this type are not abundant, but enough were found to allow construction of trend lines for several chemical parameters from 1854 to the present. The results clearly show a changing Lake Erie water chemistry. (SE)

17. Ayers, John C. 1962. Great Lakes waters, their circulation and physical and chemical characteristics. In: Am. Assoc. Adv. Sci. Pub. 71:71-89. Reprinted in: Univ. Mich. Great Lakes Res. Div. Collected Reprints. 1:607-625.

These data indicate that, in the past half-century, all the Great Lakes except Superior have undergone the increase in total dissolved solids that accompanies introduction of wastes, eutrophication of the lake, and decline in water quality. Whether or not all the several Great Lakes are in process of deterioration, as is Lake Erie, can be ascertained by using data as a starting point and making a comparison of the total solids dissolved in each one.

18. Baier, Robert E. 1970. Surface quality assessment of natural bodies of water. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. pp. 114-127.

Multiple attenuated internal reflection (MAIR) spectroscopy is sensitive to surface films as thin as monolayers transferred from air/water interfaces. Repetitive surface samples have been obtained from natural bodies of water by a simple dip technique with variations in Langmuir-Blodgett transfer mechanisms used to favor single film or multilayer deposition. During the 1969 recreational season on Lake Chautauqua, the method demonstrated such phenomena as weekend "bursts" of hydrocarbon surface pollutants associated with peak recreational activity, rapid natural "cleansing" of the Lake surface, recognition of proteinaceous substances as major components of bubbles marking wind streaks in the Lake, and of billowing foam accumulated along the windward shore. Application of the method to the Buffalo River demonstrated trapping of surface oil in the upper River segments, with only minor outflow of oily surface pollutants into Lake Erie.

Bails, Jack D. - See: Ronald J. Evans, No. 124.

19. Baker, David B. and Jack W. Kramer. 1973. Phosphorus sources and transport in an agricultural river basin of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 858-871.

The mean annual export of total phosphorus (as P) from a 3237 km^2 (1251 mi^2) portion of the Sandusky River Basin was determined to be 454 metric tons (500 short tons). Annual point source inputs of phosphorus within the study area were observed to be 118 metric tons (130 short tons). Assuming all point source phosphorus leaves the system, a minimum diffuse source component of the output would be 336 metric tons (370 short tons) or 74% of the total output. This represents a diffuse phosphorus loading coefficient of 103 kg/yr/km^2 (591 lb/yr/mi^2), a value 2.4 times as large as the 44 kg/yr/km^2 (250 lb/yr/mi^2) which is used to calculate rural runoff in much of the Lake Erie Basin. During 1972, a year of high runoff, in excess of 980 metric tons (1078 short tons) of phosphorus moved out of the study area.

It is suggested that the diffuse source loading coefficient represents a eutrophication index related to land use in the study area. The reduction of phosphorus loading into Lake Erie from diffuse sources will require comprehensive land use planning and implementation. Reduced values for the diffuse phosphorus loading coefficient, corrected for annual variations in runoff, would provide a measure of progress towards less eutrophic land use management in the Basin.

Ball, Robert C. - See: J. James Roosen, No. 281.

20. Barbalas, Louis X. (Ed.). 1973. Directory and project forecasts, the Great Lakes - 1973. NOAA. Lakes Surv. Center. Detroit, Mich. 280 p.

The publication is made up of proposals for study projects on the Great Lakes.

21. Bardarik, Daniel G., Jon C. Alden, Robert L. Shema and Albert R. Kupiec. 1971. A study of the effects of heated discharges on the ecology of Presque Isle Bay, Erie, Pennsylvania. Environmental Sciences, Inc. Pittsburg, Pa. 232 p.

Water quality in Presque Isle Bay is influenced by numerous treated and untreated municipal and industrial waste discharges. The report presents the data from the chemical parameters which were monitored from May to September, 1971.

22. Barry, David E. 1974. Commentary on the Erie County 1973 stream survey report. Erie County Health Dept. Env. Health Services. Buffalo, N. Y. 24 p.

The report discusses the streams in terms of: changes in chemical parameters between 1970 and 1973; changes in biological parameters between 1972 and 1973; and possible explanations of these changes. Known actions which may have influenced these changes are mentioned. Where possible, a prognosis of the future quality of each stream is included.

23. Barry, James P. 1972. The fate of the lakes: A portrait of the Great Lakes. Baker Book House. Grand Rapids, Mich. 192 p.

This book is a general commentary on the Great Lakes, including Lake Erie. The discussion contains information about the amount of mercury in fish captured from Lake Erie. The way in which pesticides can move up the food chain is described.

24. Bartsch, A. F. 1970. Accelerated eutrophication of lakes in the United States: Ecological response to human activities. Env. Poll. 1:133-140.

Natural sources of nutrients are: tributary drainage of land areas of great variety ranging from mountain slopes to level plains, from wooded lands to rangeland and prairie; soil ero-

sion, both water-borne and airborne; biological sources, such as excreted droppings from waterfowl, other birds, animals, leaf-fall, and nitrogen fixation; and the input from rain, snow, and dust, all contribute to eutrophication. Recent observations have shown that, in some farming areas, nutrient losses from barnyards and feedlots are special points of concern. It has been estimated that animals currently under confined feeding the the United States yield pollutional wastes equal to sewage from 850 million people. Treatment of municipal and industrial wastes for phosphorus is now available, and pollution control programs are already adopted for Lakes Erie, Michigan, and Superior.

Beeton, Alfred M. - See: S. L. Daniels, et al, No. 105.

Beeton, Alfred M. - See: J. S. Marshall, et al, No. 222.

25. Beeton, Alfred M. 1960. Great Lakes limnological investigations. Univ. Mich. Great Lakes Res. Div. Proc. 3rd Conf. on Great Lakes Res. Pub. 4: 123-128.

A data table of chemical concentrations is given in the paper. (SE)

26. Beeton, Alfred M. 1961. Environmental changes in Lake Erie. Trans. Am. Fish. Soc. 90(2):153-159.

Comparison of data compiled during the past 60 years with those from recent studies shows that major changes have occurred in the bottom and fish faunas of Lake Erie. The concentrations of various major ions have increased as much as 10 ppm. The mean annual water temperatures are approximately 2°F warmer today than during the 1918-28 period. Low levels of dissolved oxygen have been observed several times since 1930, and recently very low concentrations were found in the bottom waters covering many square miles of the Central Basin. Although similar conditions hay have existed in the past, it appears that greater areas are involved at the present.

27. Beeton, Alfred M. 1963. Limnological survey of Lake Erie 1959 and 1960. Great Lakes Fish. Comm. 6: 32 p.

Federal, provincial, state, and university organizations participated in cooperative limnological surveys of Lake Erie in September 1959 and August 1960 to determine the extent and severity of the low dissolved-oxygen content of the hypolim-

netic waters. Observations were restricted to the Central Basin in 1959, but were lake-wide in 1960. Approximately 70 percent of the bottom waters of the Central Basin had a serious oxygen deficiency during both years. Data were obtained also on the distribution of temperature, transparency, specific conductance, pH, and phenolphthalein and total alkalinity. The distributions of the chemical values are discussed in terms of their relationships to each other, and to thermal stratification, river outflow, lake morphometry, and lake currents.

28. Beeton, Alfred M. 1966. Indices of Great Lakes eutrophication. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:1-8.

This article cites ion chemical data on: calcium; chlorides; sodium; potassium; and sulfate for effects on eutrophication processes. Oxygen depletion studies done by Carr (1962) were also discussed.

29. Beeton, Alfred M. 1969. Changes in the environment and biota of the Great Lakes. In: Eutrophication: Causes, Consequences, Correctives. National Acad. Sci. pp. 150-189.

Total dissolved solids, calcium, chloride, sodium-plus-potassium, and sulfate have increased significantly during the period of record. Total dissolved solids were about 56 ppm higher in 1965 than in 1910. Calcium, chloride, sodium-plus-potassium, and sulfate have increased by 8, 16, 5, and 12 ppm, respectively, during the same period. Magnesium has not changed. Nitrogen and phosphorus data are available, but much of this information is not usable because of uncertainty as to the units in which the data were recorded. Data from the few open-lake studies of the Western Basin indicate that ammonia-N increased fivefold and total nitrogen increased about threefold between 1930 and 1958. Total phosphorus concentrations appear to have doubled between 1942 and 1958. Studies of seasonal and local changes in dissolved oxygen indicate a much greater oxygen demand in the lake today than in the past.

30. Beeton, Alfred M. 1970. Statement on pollution and eutrophication of the Great Lakes. Univ. Wisc. Center for Great Lakes Studies. Milwaukee, Wisc. Rept. 11. 28 p. + figures.

The purpose of the paper is to present a resume of the pollu-

tion aspects which are pertinent to an understanding of what happened to the Lakes and which may serve as a basis for remedial measures. The text deals with problems of eutrophication and pollution and remedial measures with details of some specific recommendations. NSQCD

31. Beeton, Alfred M. 1970. Statement on pollution and eutrophication of the Great Lakes. Statement to the Sub-committee on Air and Water Pollution of the Committee of Public Works, U. S. Senate. Tech. Rept. pp. 108-151.

A discussion of the ecology of Lake Erie in relation to the Great Lakes area is the subject of this presentation. The environmental changes include: pollution of inshore areas; long-term effects of the open waters; and the various changes in sediments are categorized.

32. Beeton, Alfred M. 1971. Chemical characteristics of the Laurentian Great Lakes. In: Robert A. Sweeney (Ed.), Proceedings of Conference on Changes in Chemistry of Lakes Erie and Ontario. Bull. Buffalo Soc. Nat. Sci. 25(2):1-20.

Many individuals and groups are responsible for the accumulated chemical information on Lake Erie. Each scientist or group which conducted a study throughout the years is cited and the kind of data obtained is listed.

33. Beeton, Alfred M. and David C. Chandler. 1966. The St. Lawrence Great Lakes. In: David G. Frey (Ed.), Limnology in North America. Univ. Wisc. Press. Madison, Wisc. pp. 535-558.

Lake Erie is shown in perspective, as it relates to the other Great Lakes in North America. A comparison of the commonly studied chemical characteristics is included in the discussion.

34. Beeton, Alfred M. and W. T. Edmondson. 1972. The eutrophication problem. J. Fish. Res. Board Canada. 29(6):673-682.

Lake Erie is compared with the other Great Lakes; the trophic state of a lake is maintained by continued inputs of nutrients. In very large lakes, the inshore environments are affected first by increased nutrient loading and, depending upon the morphology and morphometry, gradually the offshore waters are

altered. The near-shore waters of Lake Michigan have greater concentrations of nitrogen and phosphorus and a lower silica content than open lake waters. Diatoms are more abundant inshore than offshore, the doubling times for diatom populations are shorter inshore, and species favored by nutrient-rich conditions are more abundant inshore. Data on plankton, nitrogen concentrations, and fish, from early studies on Lake Erie, show progressive changes from the shore lakeward and from the Western Basin eastward.

35. Beir, C. J. 1972. A submersible automatic dissolved oxygen-temperature monitoring system. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo. U. S. Env. Protection Agency. Washington, D. C. Tech. Rept. TS-05-71-208-24. pp. 133-140.

Until now, sampling techniques for dissolved oxygen depletion rates were limited to shipboard, manual grab samples or conbination dissolved oxygen-temperature profiles, utilizing semi-automatic instrumentation. Surveys of this type were restricted in frequency and duration by prevailing weather conditions. In the summer of 1970, following modifications, five commercially available dissolved oxygen monitors designed to measure and record in situ dissolved oxygen and temperature simultaneously and on a continuous basis, were placed at five locations in the Central Basin hypolimnion of Lake Erie. They successfully documented, for the first time, on a continuous basis, the dissolved oxygen depletion rate in the hypolimnion, over a period of fifty days.

Bell, Frank H. - See: Bernard S. Meyer, et al, No. 231.

36. Benoit, Richard J. 1972. Wash-out processes in wastewater management--chemical. In: Wash-out Processes in Fresh Water Systems. Ohio State Univ. Proc. 5th Sym. Water Resources Res. pp. 56-61.

The capacity of a stream to recover from pollution or to assimilate wastewater without significant loss of ecological quality depends upon a host of factors: climatic; physiographic; physical; chemical; and biological. The object of the presentation is to discuss some of the more important chemical factors or natural chemical processes operating in self-purification. The general chemical principle of solubility equilibria involving common mineral species and water containing carbon dioxide from air set a base-line for the chemical composition of natural waters. In his manipulations of the chemical natural resources, man forces chemical condi-

tions away from equilibrium. An important geochemical task for the future is the determination of the limits of the natural forces tending to restore equilibrium.

Bieber, Glen F. - See: Frank J. Little, Jr., et al, No. 212.

37. Bird, John. 1966. Our dying waters. Saturday Evening Post. April 23. 239:29-35, 86-87.

A popularly written article, this one mentions Lake Erie as one of the many bodies of water with a polluted waters problem.

38. Black, Hayse H. and Earl Devendorf. 1954. Industrial pollution of international boundary waters along the Niagara Frontier. Sewage and Industrial Wastes. 26(10):1259-1285.

The type of pollution caused by each industry using the water for waste disposal is described. The extent to which harbor pollution influences the water quality of the lake is not clear.

39. Blanton, J. O. and A. R. Winklhofer. 1971. Circulation of hypolimnion water in the Central Basin of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 788-798.

The amount of dissolved oxygen and fluctuations in water temperature are part of the data for a study of hypolimnion characteristics.

40. Blanton, J. O. and A. R. Winklhofer. 1972. Physical processes affecting the hypolimnion of the Central Basin of Lake Erie. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo. U. S. Env. Protection Agency. Washington, D. C. Tech. Rept. TS-05-71-208-24. pp. 9-38.

A variety of <u>in situ</u> instrumentation was deployed in Lake Erie during "Project Hypo" to measure the physical processes governing the principal movements of hypolimnion water and to document the hypolimnion dissolved oxygen content changes in detail. The data were analyzed to determine the relationship between the dominant winds, dominant motions in the hypolimnion and the response of the thermocline to these motions.

Bligh, E. Graham - See: J. F. Uthe, No. 346.

41. Bligh, E. Graham. 1970. Mercury contamination in fish. Summary of material presented at 20th Ann. Inst. Public Health Inspectors. Winnipeg, Man. pp. 10-19.

The mercury content of fish taken from Lake Erie, the Detroit River, and other Canadian tributaries to Lake Erie is presented in the data tables.

42. Bligh, E. Graham. 1970. Mercury and the contamination of freshwater fish. Fish. Res. Bd. Canada. Winnipeg, Man. Manuscript Rept. Ser. 1088: 27 p.

The amount of mercury accumulated in the tissues of various Lake Erie fish is enumerated in a table.

43. Bligh, E. Graham. 1971. Environmental factors affecting the utilization of Great Lakes fish as human food. Limnos. 4(1):13-16.

The concentrations of several toxic substances which can accumulate in fish are described. Data from Lake Erie specimens is compared with values obtained from fish from the other Great Lakes.

44. Borchardt, J. A. 1969. Eutrophication--causes and effects. J. Am. Water Works Assoc. 61(6):272-275.

The article presents a general history of the problem. When referring to the change, limnologists speak of the geometry of the system as a factor in eutrophication. It is usually expressed as an average depth-to-volume ratio, since that value expresses this element of productivity in the best way possible.

In Lake Erie, then, the following factors become major determinants in the rate of development of the trophic character of the lake: geology of region, size and configuaation of lake basin, type and size of watershed, latitude of lake's location, and man's activities. NSQCD

45. Boulton, Patricia and Leo J. Hetling. 1972. A statistical analysis of the mercury content of fresh water fish in New York State. N. Y. Dept. Env. Cons. Env. Quality Res. and Dev. Unit. Albany, N. Y. Tech. Paper 19. 16 p.

The New York State Departments of Health, Agriculture and

Markets, and Environmental Conservation undertook an extensive, cooperative program to collect basic data on the concentration of mercury in the State's environment. As part of this program, over 3,200 fish have been collected and analyzed to date. This paper presents a statistical analysis of the fish data collected.

Breidenbach, Andrew W. - See: Leo Weaver, et al, No. 364.

46. Breidenbach, Andrew W., C. G. Gunnerson, F. K. Kawahara, J. J. Lichtenberg and R. S. Green. 1967. Chlorinated hydrocarbon pesticides in major river basins, 1957-65. U. S. Dept. Health, Education and Welfare. Cincinnati, Ohio. 82(2):139-156.

The results of the synoptic pesticide surveys of 1964 and 1965 and the examination of stored carbon adsorption extracts for water years 1958 through 1965 reveal that dieldrin has dominated pesticide occurrences in all river basins since 1958. Lake Erie and its tributary waters analysis data is included in the results section.

47. Breidenbach, Andrew W., J. J. Lichtenberg, C. F. Henke, D. J. Smith, J. W. Eichelberger Jr. and H. Stierli. 1966. The identification and measurement of chlorinated hydrocarbon pesticides in surface waters. U. S. Federal Water Poll. Control Admin. Washington, D. C. 70 p.

There are three FWPCA surveillance sampling stations on Lake Erie. This publication describes the various methods for identification of the chlorinated hydrocarbon pesticides in water.

48. Brinkhurst, Ralph O. 1966. Detection and assessment of water pollution using oligochaete worms. Water and Sewage Works. October-November. 4 p.

In Western Lake Erie it was established that some organisms tolerated polluted inflows quite readily, that others seemed only to occur in the open lake, and that a third category of species seemed to be distributed along the shore line with no reference to polluted inflows.

49. Brinkhurst, Ralph O., A. L. Hamilton and H. B. Herrington. 1968. Components of the bottom fauna of the St. Lawrence, Great Lakes. Univ. Toronto. Great Lakes Inst. Toronto, Ont. PR 33: 50 p.

Maps of the oxygen saturation of the bottom water of Lake Erie in the summer are provided.

Britt, N. Wilson - See: Edwin J. Skoch, No. 298.

50. Britt, N. Wilson. 1955. Stratification in Western Lake Erie in summer of 1953: Effects on the Hexagenia (Ephemeroptera) population. Ecology. 36(2): 230-244.

This report considers the effects of dissolved oxygen levels on survival of biological organisms.

51. Britt, N. Wilson and James T. Addis. 1965. Limnological studies of the island area of Western Lake Erie, 1959-1965. Ohio State Univ. Nat. Resources Inst. Spec. Rept. 141 p. + Tables.

This study was undertaken to determine what, if any, relationship exists between changing limnological conditions and the sport and commercial fishery. To gather pertinent information, the concentrations of the chemicals which affect biological systems were monitored.

52. Britt, N. Wilson, Edwin J. Skoch and Kenneth R. Smith. 1968. Record low dissolved oxygen in the island area of Lake Erie. Ohio J. Sci. 68(3):175-179.

The first recorded severe oxygen depletion over an extensive area in the Western Basin of Lake Erie occurred in 1953. Because sampling in the past was done at irregular intervals, it has been difficult to determine the severity, or duration of these low-oxygen conditions. In order to get more reliable data, a program of daily sampling was initiated. From 22 June to 31 August 1966, data were collected daily at a single station south of Rattlesnake Island. Dissolved oxygen near the bottom fluctuated greatly during this time, reaching a low of 0.1 ppm on 1 July, the lowest value ever recorded from this area, and a high of 9.2 ppm on 19 July. Following this, two more periods of low dissolved oxygen occurred, the first of 3.7 ppm on 7 August and the other of 3.0 ppm on 30 August. In each of these cases, the low-oxygen condition was accompanied by an average wind speed of about six knots and an air temperature of about 26° C. In each case the drop in oxygen near the bottom was very rapid. The mean dissolved oxygen near the bottom for the summer was 5.0 ppm (61.6 percent saturation). Statistical analysis indicates a significant relationship between wind speed and dis-

solved oxygen.

Brown, Danley F. - See: Frank J. Little, Jr., et al, No. 212.

53. Brown, Edward H., Jr. 1953. Survey of the bottom fauna at the mouth of ten Lake Erie, south shore rivers: Its abundance, composition, and use as index of Stream pollution. In: Lake Erie Pollution Survey. Ohio Dept. Nat. Resources. Div. Water. Columbus, Ohio. Final Rept. pp. 156-169.

The following conclusions were made: environmental conditions allow only a limited fauna at the river mouths; the most heavily polluted areas were near large human populations; heavy organic pollution was found to exist at only two of the river mouths, the Black and the Maumee; only the Maumee River has an appreciable pollutional effect on Lake Erie, and that effect has increased in the past twenty years.

54. Bruce, J. P. 1970. Water pollution and the role of the Canada Centre for Inland Waters. Canadian Geog. J. pp. 182-193.

Recognizing the technological need and opportunity, and noting that at the federal level research efforts were undertaken by a number of departments, the government in 1966 restructured the Department of Energy, Mines and Resources to coordinate federal water programs. The Canada Centre for Inland Waters at Burlington, Ontario, brings together a number of water research activities of three federal departments, Energy, Mines and Resources (EM&R), Fisheries and Forestry (Fisheries Research Board--FRB), and National Health and Welfare (NH&W). The emphasis in the Centre's program is on antipollution research, on studies of all aspects of lakes including non-pollution oriented research on ice, wave forces, erosion, etc., and on related research in hydraulics.

55. Bruce, J. P. 1972. Meteorological aspects of Great Lakes pollution. Dept. Env. Inland Waters Branch. Reprint No. 171. pp. 127-132.

The pollution problems of the Great Lakes can be broadly divided into three major categories: eutrophication, toxic substances, and waste heat. The first of these, eutrophication, is the problem of over-enrichment of the lakes by nutrients, in particular phosphorus and nitrogen. The second major category of pollution problems includes toxic substances. The problem which has received most widespread attention re-

cently has been the mercury contamination in Lake St. Clair, parts of Lake Erie and parts of Lake Ontario. Mercury from industrial processes has been discharged into the Lakes and has settled into the sediments. Once in the sediments, the metallic mercury is converted to the highly toxic methyl form by bacterial action, and is subsequently taken into the food chain. Certain species of fish taken in nearly all parts of the Great Lakes system have been found to have more than 0.5 ppm mercury in their flesh and have been deemed unfit for human consumption. Other toxic substances which are appearing in increasing concentrations in the Great Lakes environment are lead, cadmium, zinc, DDT, dieldrin, polychlorinated biphenyls (PCBs) and several others. A third potential problem lies in the possible effects on the lake waters biotic communities of waste heat discharged from power plants and other industrial sources. NSQCD

56. Brydges, Thomas Gerald. 1971. Chlorophyll a - Total phosphorus relationships in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 185-190.

Lake Erie chlorophyll a data for 1967, 1968 and 1969 have been examined with particular reference to relationships with inorganic nitrogen and total phosphorus concentrations. In 1967, the average chlorophyll a and total phosphorus concentrations at 87 open lake stations (three to five measurements at each) were directly proportional. Detroit, Raisin and Maumee River stations were characterized by high total phosphorus and relatively lower chlorophyll a concentrations. Lake stations included the Western Basin and a five mile wide band along the north shore from Point Pelee to Buffalo.

There were no apparent trends between chlorophyll a and inorganic nitrogen concentrations. The chlorophyll a and total phosphorus concentrations measured in 1968 and 1969 were also directly proportional. Eight stations in the Western Basin were sampled for nine successive days in July, 1968. In 1969, 97 stations (422 measurements) were sampled over the full length of the Lake.

These extensive empirical observations are taken as evidence that phosphorus is an algal growth limiting factor in Lake Erie.

57. Brydges, Thomas Gerald. 1971. An intensive biochemical survey in Western Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 191-197.

Eight stations in Western Lake Erie were sampled at two depths at the same time each day for nine consecutive days in July 1968. Thirteen chemical and four bacteriological tests were made on each sample. The purpose was to obtain information tn the extent, causes and consequences of the large variations in water quality with time observed in earlier surveys.

During this survey, the total phosphorus and total iron concentrations were directly related and it is postulated that they coprecipitated, thus removing the extremely high phosphorus load from solution. This results in less total growth than might be expected in the absence of the iron inputs. The premise is supported by a numerical comparison of Western Lake Erie and Lake Sebasticook with respect to both loadings and concentrations of phosphorus and the resulting chlorophyll a concentrations.

Chlorophyll a concentrations and bacterial numbers were inversely related suggesting that a symbiotic relationship is not present in this case.

Burdick, George E. - See: Raymond J. Lovett, et al, No. 214.

Burdick, George E. - See: Irene S. Pakkala, et al, No. 260, 261.

58. Burkholder, Paul R. 1929. Biological significance of the chemical analysis. In: Charles J. Fish (Ed.), Preliminary Report on the Cooperative Survey of Lake Erie, season of 1928. Bull. Buffalo Soc. Nat. Sci. Buffalo, N. Y. 14(3):65-72.

Any discussion of the biological significance of environmental factors in a body of water calls in large measure for chemical evidence. The chemical conditions in a lake affect the organisms living there and in turn the organisms bring their influence to bear upon the chemical status in the water. Thus there exists an interlocked relationship between the chemistry and organic life. The data obtained during the progress of this survey show certain conditions whose biological importance warrant discussion.

59. Burkholder, Paul R. 1960. Distribution of some chemical values in Lake Erie. In: Charles J. Fish (Ed.), Limnological Survey of Eastern and Central Lake Erie, 1928-1929. U. S. Fish and Wildlife Service. Spec. Sci. Rept. - Fish. No. 334. pp. 70-109.

During the survey the following determinations were made: albuminoid ammonia, free ammonia, nitrate nitrogen, dissolved oxygen, phenolphthalein alkalinity, methyl-orange alkalinity, hydrogen-ion concentration, chloride, and turbidity. For purposes of the present discussion, the data obtained in 1928-29 are utilized. The nitrogen determinations of the first season and the oxygen, carbon dioxide, pH, total alkalinity, chloride, and turbidity figures for the second year are selected for treatment in detail. Results of all the analyses for the second year may be found in the appended tables.

Burns, N. M. - See: A. S. Menon, et al, No. 227, 228.

60. Burns, N. M. and C. Ross. 1971. Nutrient relationships in a stratified eutrophic lake. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 743-748.

Seven intensive chemical surveys of the Central Basin of Lake Erie were carried out at four day intervals during the month of August 1970. Special emphasis was placed on measuring the oxygen and nutrient levels in the hypolimnion. The volume of the hypolimnion was seen to increase during the study and a model has been developed for the calculation of the quantities of materials transferred into the hypolimnion.

The complete oxygen depletion pattern was seen to develop first in the western part of the basin and proceed eastward. The progression was faster in the shallow areas, especially along the south shore. The majority of the oxygen depletion was due to organic decay. Iron, manganese and phosphorus concentrations were seen to increase dramatically when the water became anoxic. A large increase in the chlorophyll content in the water was noted when the anoxic hypolimnion water began to mix with the surface water. It appears necessary that all phosphorus inputs be reduced drastically as a means of reducing productivity and thus maintaining oxygen concentration in the water during summer stratification. This is subsequent to the fact that 88% of the oxygen depletion is attributable to the decay of organic material which were phosphorus limited during its growth cycle.

61. Burns, N. M. and C. Ross. 1971. "Project Hypo": Discussion of findings. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 761-767.

The areas of discussion are: cause and site of oxygen depletion; sediment oxygen demand; hypolimnion volume increase; and phosphorus and nitrogen elimination from the lake system. A short index of major findings is included.

62. Burns, N. M. and C. Ross. 1972. Oxygen-nutrient relationships within the Central Basin of Lake Erie. In: Herbert E. Allen and James R. Kramer (Eds.), Nutrients in Natural Water. John Wiley and Sons. New York, N. Y. pp. 193-250.

The approach in this study has been to monitor a set of five sequential environmental reactions and then sum the five reactions into a net result for the period of observation. The first reaction represents the changes that occurred in the hypolimnion during the period from the end of the first survey to the end of the second survey. The difference then between the dissolved oxygen calculated to be present in the hypolimnion at the end of the first and second surveys represented the dissolved oxygen that had disappeared into other chemical forms during the time interval; its rate of disappearance was also calculated. Also, by noting which other oxygen-containing components increased in quantity during the time interval, it was possible to estimate the extent of the various chemical transformations involving oxygen.

The first and most obvious result of the investigation was that the hypolimnion volume increased by almost 100% during the course of the study. This phenomenon involved thinning and elevation in depth of the thermocline. The hypolimnion volume increase was most unexpected and caused much concern about the possibility of valid budget calculations. The concentration of the various materials in the hypolimnion would have remained essentially unchanged with a loss of volume; however, with increasing hypolimnion volumes, water having a quite different concentration of the reactants was intorduced into the hypolimnion from the epilimnion.

63. Burns, N. M. and C. Ross. 1972. Oxygen-nutrient relationships within the Central Basin of Lake Erie. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo. U. S. Env. Protection Agency. Washington, D. C. Tech. Rept. TS-05-71-208-24. pp. 85-119.

Seven intensive chemical surveys of the Central Basin of Lake Erie were carried out at 4-day intervals during the month of August 1970. Special emphasis was placed on measuring the oxygen and nutrient levels in the hypolimnion. The volume of

the hypolimnion was seen to increase during the study and a model has been developed for the calculation of the quantities of materials transferred into the hypolimnion. The complete oxygen depletion pattern was seen to develop first in the western part of the basin and proceed eastwards. The progression was faster in the shallow areas, especially along the south shore. The majority of the oxygen depletion was due to organic decay. Iron, manganese and phosphorus concentrations were seen to increase dramatically when the water became anoxic. A large increase in the chlorophyll content in the epilimnion water was noted when the anoxic hypolimnion water began to mix with the surface water. It appears necessary that oxygenated conditions be maintained in the water as a simple mechanism for ensuring that little of the phosphorus in the sediments returns to the overlying water.

64. Burns, N. M. and C. Ross. 1972. Project Hypo: Discussion of findings. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo. U. S. Env. Protection Agency. Washington, D. C. Tech. Rept. TS-05-71-208-24. pp. 120-126.

There were two main oxygen depletion mechanisms operating in the Central Basin. The smaller effect was the oxidation of reduced metallic species and this caused approximately 12% of the observed depletion. The larger effect was the oxygen used in the bacterial oxidation of organic materials and constituted 88% of the observed depletion. The evidence for this statement is chemical and bacteriological.

The average oxygen demand for the basin for the month of August calculated by Burns and Ross by means of the Limnos cruise data was 12.2 millimoles O_2 m^{-2} day^{-1} (0.39 gm O_2 m^{-2} day^{-1}). Evidence is reported indicating 76% of the phosphorus and 57% of the nitrogen in algal material which sediments to the lake floor is retained if oxic conditions occur in the overlying water.

65. Burns, N. M. and C. Ross. 1972. Project Hypo - an introduction: An intensive study of the Lake Erie Central Basin hypolimnion and related surface water phenomena. In: Noel Burns and Curtis Ross (Eds.), Project Hypo. U. S. Env. Protection Agency. Washington, D. C. Tech. Rept. TS-05-71-208-24. pp. 1-2.

Some oxygen deficiency was observed in the Central Basin in 1929. Since that time the literature has been populated with

studies indicating increased oxygen deficiencies throughout the Central Basin. Carr indicated that oxygen depletion in the Central Basin hypolimnion had gradually increased in area over the last three decades. FWPAC (1968) estimated the Central Basin bottom water to be oxygen deficient (2 mg/l or less) over an area of approximately 2600 square miles.

66. Business Week. 1965. Test case on pollution: Big clean-up begins. Business Week. August. 1876: 25-26.

U. S. Public Health Service presents charges against industries and municipalities for polluting the waters of Lake Erie. NSQCD

67. Canada Centre for Inland Waters. Undated. Annual Report - 1968. Dept. Energy, Mines and Resources. Fish. Res. Bd. Dept. National Health and Welfare. Burlington, Ont. 30 p.

The report describes the various activities of the Canada Centre. The scientific interests and the staff research is described. NSQCD

68. Canada Centre for Inland Waters. Undated. Lake Erie cruise 69-101, February 6-27; cruise 69-103, May 29-June 4; cruise 69-104, July 2-6; cruise 69-105, July 28-August 2, 1969. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 1. 101 p.

Data from the analysis of water samples collected during eight lake-wide monitoring cruises is listed in the publication. The surveys are designed to develop a body of information which will provide data needed for determining optimum pollution abatement and water management programs.

69. Canada Centre for Inland Waters. Undated. Lake Erie cruise 69-107, August 25-30; cruise 69-108, September 13-18; cruise 69-110, October 14-20; cruise 69-111, December 7-13, 1969. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 2. 140 p.

This report is one of a series listing bacteriological, biological, chemical, and physical data for the waters of Lake Erie, observed by Canadian Government agencies during the period February 6-December 13, 1969.

70. Canada Centre for Inland Waters. 1969. Lake Erie cruise 66-11, August 8-14, 1966. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 8. 105 p.

This report contains limnological data gathered from research and monitoring performed for the International Joint Commission. Information is directed to the question to what extent, from what cause, and in what location is pollution taking place. Eighteen cruises collected samples from Lake Erie for chemical analysis.

71. Canada Centre for Inland Waters. 1970. Annual Report - 1969. Dept. Energy, Mines and Resources. Fish. Res. Bd. Dept. National Health and Welfare. Burlington, Ont. 40 p.

Discussion of the report centers around personnel, proposed projects, and completed studies. The effect of chemicals on the Lake Erie biological systems is delineated. NSQCD

72. Canada Centre for Inland Waters. 1970. The control of eutrophication. Canada Centre for Inland Waters. Burlington, Ont. Tech. Bull. 26. 10 p.

A discussion of the respective role of phosphorus, nitrogen and carbon as critical elements in limiting the eutrophication process. To obtain some idea of the relative magnitude of these sources of carbon in a natural lake system, consider Lake Erie. The annual loading of BOD to the whole lake is estimated at 200,000 tons (Report to IJC, 1969) and the carbon equivalent is 75,000 tons. In contrast the amount of bicarbonates in the lake (20-25 ppm carbon) is 10 to 12.5 million tons of carbon, which is approximately 150 times as much as the carbon from sewage wastes in an entire year. It has been estimated (Harlow, 1968) that at the height of the growing season the biomass weighs 4.9 million tons and this contains about 1.8 million tons of carbon.

73. Canada Centre for Inland Waters. 1970. Lake Erie cruise 67-101, May 30-June 7; cruise 67-102, June 12-18; cruise 67-103, June 19-29, 1967. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 1. 230 p.

This report is one of a series listing bacteriological, biological, chemical, and physical data for the waters of Lake Erie, observed by Canadian Government agencies during the

period May 30-October 30, 1967.

74. Canada Centre for Inland Waters. 1970. Lake Erie cruise 67-109, August 21-31; cruise 67-111, September 11-21; cruise 67-113, October 2-9; cruise 67-115, October 23-29, 1967. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 3. 226 p.

This report contains limnological data gathered from research and monitoring performed for the International Joint Commission. Information gathered was directed to the question are the waters polluted, to what extent, from what cause, and in what locality.

75. Canada Centre for Inland Waters. 1970. Lake Erie cruise 68-102, May 17-24; cruise 68-104, June 15-19; cruise 68-108, July 29-August 3, 1968. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 1. 152 p.

Three Federal Government agencies combined to establish the Canada Centre for Inland Waters, the Department of Energy, Mines, and Resources, the Fisheries Research Board, and the Department of National Health and Welfare. The Department of Energy, Mines, and Resources coordinates the programs and provides support facilities to the participating agencies and to university scientists undertaking projects in collaboration with the Centre's agencies. Between April and December, 1968, an extensive field program was conducted on the Great Lakes. The three participating departments conducted a number of interdisciplinary surveys designed to develop a body of information which will provide vital data needed for determining optimum pollution abatement and water management programs.

76. Canada Centre for Inland Waters. 1970. Lake Erie cruise 68-109, August 31-September 3; cruise 68-111, September 28-October 4; cruise 68-112, November 4-10, 1968. Canadian Oceanographic Data Centre. Burlington, Ont. Limnological Data Rept. 2. 140 p.

Water quality data gathered during six monitor cruises in 1968 are contained in the present series. Accompanying diagrams show the geographical locations of the observations listed in this data record together with the vessel's track and the locations of bathythermograph lowerings. These sur-

veys, along with data collected from fixed moorings of instruments in the lakes and other studies, are designed to develop a body of information which will provide vital data needed for determining optimum pollution abatement and water management programs for the Great Lakes.

77. Canada Centre for Inland Waters. 1971. Canada Centre for Inland Waters - 1970. Dept. Fish. and Forestry. Burlington, Ont. 53 p.

The annual report describes areas of activity as: evaluation of the possible environmental impact of nitrilotriacetate; development of survey program for mercury pollution as well as other toxic substances; contingency plans for oil spills; project hypolimnion; cooperating in international pollution abatement programs; and acting in an advisory capacity for legislators if called upon. Specific activity on Lake Erie is a series of surveys. During the year, ten cruises collected water samples which were assayed for 24 chemical parameters. In all, 25 stations were visited every four days.

78. Canada Centre for Inland Waters. 1972. Canada Centre for Inland Waters - 1971. Dept. Env. Burlington, Ont. 87 p.

Each department of the Canada Centre for Inland Waters has a section of the report detailing the activities of the past year. The chemical limnology section was responsible for planning and evaluating results of the Chemical Monitor Cruises on the Great Lakes. Quintuplicate determinations on samples from six stations in Lake Erie were completed. Sediment cores from three stations in the Central Basin were selected at monthly intervals from May to October, to study the chemical properties of the interstitial water and the effects of seasonal changes in the chemistry of overlying water.

79. Canada Centre for Inland Waters. 1972. Canada Centre for Inland Waters - 1972. Dept. Env. Burlington, Ont. 125 p.

The report describes the activities of the Centre for Inland Waters in terms of research, environmental monitoring, pollution surveys, and personnel support for programs designated by international agreements. In all, three biochemical monitoring cruises collected data on pH, total alkalinity, soluble and total nutrients, major ions and some trace elements of Lake Erie waters. An appendix of publications and presentations by members is included in the report.

80. Canada Fisheries Research Board. 1971. Review 1969-1970. Fish. Res. Bd. Canada. Ottawa, Ont. 217 p.

The publication contains a discussion of the activities, interests, and publications of the members of the Fisheries Research Board.

81. Canada Inland Waters Branch. 1972. Guidelines for water quality objectives and standards: A preliminary report. Dept. Env. Inland Waters Branch. Ottawa, Ont. Tech. Bull. 67. 156 p.

The present state of a body of water, as well as its intended use, serve as part of the criteria for assigning water quality objectives and standards. These standards are intended for use throughout Canada.

82. Canada Technical Working Group on Contingency Plans. 1971. Interim Federal Contingency Plan for oil and toxic materials spills, field manual. Env. Canada. Ottawa, Ont. 59 p.

Amherstburg is the coordinating center for a possible oil or toxic materials spill in Lake Erie. The report includes the procedure for the protection of the population. The system for alerting cooperating agencies of the Federal network is described. The survey methods for deciding the extent of a hazard, as well as the specific counter measures, technology, and the application of these measures is detailed.

Cardenas, Raul R., Jr. - See: Leonard Ciaccio, et al, No. 96.

Carey, Walter E. - See: Paul L. Zubkoff, No. 381.

83. Carr, John F. 1962. Dissolved oxygen in Lake Erie, past and present. Univ. Mich. Great Lakes Res. Div. Proc. 5th Conf. on Great Lakes Res. Pub. 9: 1-14.

Data presented on dissolved oxygen in Lake Erie in 1928-61 include a brief sumaary of records from each of the major limnological surveys made during the period and charts indicating areas where dissolved-oxygen deficiencies have been detected. Critically low concentrations of dissolved oxygen may have existed at the time of some of the earlier studies, but may not have been detected because of shortcomings in the sampling technique, the infrequency of sampling, and the lack of samples from some areas. Oxygen depletion in the Central

Basin appears to have become gradually more extensive over the last three decades. At the present time, hundreds of square miles of the bottom waters have no detectable dissolved oxygen during part of the year. The vertical distribution of oxygen is affected sharply by the temperature gradient. In the absence of a metalimnion the percentage saturation of oxygen near the bottom is usually 60% or greater.

84. Carr, John F., Vernon C. Applegate and Myrl Keller. 1965. A recent occurrence of thermal stratification and low dissolved oxygen in Western Lake Erie. Ohio J. Sci. 65(6):219-327.

Instances of thermal stratification have been detected only occasionally in Western Lake Erie during the past 40 years, but when it does occur it is of considerable importance because of associated dissolved oxygen (DO) depletion in the hypolimnion. Data collected in June of 1963 give an indication of the meteorological conditions necessary to produce this thermal stratification. These conditions are: daily wind speed of less than 3.1 m/sec (7 mph); highest wind speed of less than 6.7 m/sec (15 mph); and an average daily temperature of more than 18.5^{o} C for approximately 5 consecutive days. Weather records for Sandusky, Ohio, show these conditions to have occurred on 33 separate occasions between 1953 and 1963. These data suggest stable thermal stratification occurs more frequently than heretofore suspected. The 1963 data also show that in only 5 days of stratification DO in the hypolimnion was reduced to less than 3 ppm, whereas 28 days were required in 1953. This increased rate of DO depletion is probably due to an increase in the oxygen demand of the bottom sediments in recent years.

85. Carr, Richard L., Charles C. Finsterwalder and Michael J. Schibi. 1972. Chemical residues in Lake Erie fish - 1970-71. Pesticides Monitoring J. 6(1):23-26.

Yellow perch, coho salmon, carp, channel catfish, freshwater drum and white bass from the Ohio shore of Lake Erie were analyzed during 1970-71 for residues of chlorinated pesticides (DDE, TDE, DDT, and dieldrin), polychlorinated biphenyls (PCB's), and mercury. All but 1 of the 80 samples analyzed contained DDT and/or its metabolites; PCB's were found in all samples. Fifty-three of the 80 samples were analyzed for mercury, and all were found positive.

Average levels of residues for the species sampled ranged

from 0.06 to 0.42 ppm for DDE; 0.07 to 0.52 ppm, TDE; 0.03 to 0.25 ppm, DDT; 0.18 to 0.90 ppm, total DDT; 0.01 to 0.07 ppm, dieldrin; 0.08 to 4.4 ppm, PCB's; and 0.12 to 0.64 ppm, mercury. The highest average residue levels of total DDT were in coho salmon and channel catfish. Average levels of PCB's were significantly higher in channel catfish, and levels of mercury were significantly higher in white bass.

86. Casper, Victor L. 1965. Phytoplankton bloom in Western Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 8th Conf. on Great Lakes Res. Pub. 13:29-35.

Western Lake Erie now exhibits many of the symptoms of an organically enriched lake. Not only has algal productivity increased greatly but a shift in dominant genera during the summer and early fall from diatoms to green and blue-green algae is occurring. Extreme vertical variations in biological and chemical parameters often occur in the Western Basin and are due primarily to concentration of the phytoplankton near the surface. During the bloom inorganic nitrogen was nearly depleted and has probably become the limiting factor in phytoplankton production. The high concentrations of soluble phosphorus indicate that it was not limiting.

Chandler, David C. - See: Alfred M. Beeton, No. 33.

Chandler, David C. - See: J. S. Marshall, et al, No. 222.

87. Chandler, David C. 1940. Limnological studies of Western Lake Erie, I. Plankton and certain physical-chemical data from the Bass Island region from September, 1938, to November, 1939. Ohio J. Sci. 40(6):291-336.

Several chemical parameters which are known to affect biological organisms were monitored during a biological survey. (BU)

88. Chandler, David C. 1942. Limnological studies of Western Lake Erie, III. Phytoplankton and physical-chemical data from November, 1939, to November, 1940. Ohio J. Sci. 42(1):24-44.

Chemical characteristics of water which can affect biological organisms are described. (BU)

89. Chandler, David C. 1944. Limnological studies of Western Lake Erie, IV. Relation of limnological and

climatic factors to the phytoplankton of 1941. Trans. Am. Micro. Soc. 63(3):203-236.

It is the purpose of this report to show the relation of climatic factors to the annual abundance of certain groups of organisms utilized by fish as food, and the effects of these factors on the general productivity of Western Lake Erie. (BU)

90. Chandler, David C. 1964. The St. Lawrence Great Lakes. In: Verh. Inter. Verein. Limnol. 15:59-75. Reprinted in: Univ. Mich. Great Lakes Res. Div. Collected Reprints. 1:280-298.

This article is a general survey of the information about the Great Lakes. The ways in which Lake Erie is unique from the other Great Lakes is brought out in discussion.

91. Chandler, David C. and Owen B. Weeks. 1945. Limnological studies of Western Lake Erie, V. Relation of limnological and meteorological conditions to the production of phytoplankton in 1942. Ecol. Mono. 15:435-456.

Several chemical parameters were studied during the course of a general limnological survey. (BU)

Charlesworth, L. James - See: Lester J. Walters, Jr., et al, No. 361.

Chau, Y. K. - See: V. K. Chawla, No. 94.

92. Chau, Y. K. and H. Saitoh. 1973. Mercury in the international Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 221-232.

The total mercury data obtained from monitoring cruises during the period 1970-71 on the four international Great Lakes were examined to assess the mercury levels in these lakes and to establish baseline values for future reference.

The surface mercury concentration of Lake Erie is slightly higher than that of Lake Ontario. It is higher in the western part than in the eastern. There were a few high mercury locations at nearshore areas which could have been related to some industrial activities. Most of the lake is well below 0.2 $\mu g/l$. The mercury distribution in bottom waters

varies by itself without any relationship to the surface distribution.

Chawla, Vinod K. - See: R. R. Weiler, No. 368, 369.

93. Chawla, Vinod K. 1971. Changes in the water chemistry of Lakes Erie and Ontario. In: Robert A. Sweeney (Ed.), Proceedings of the Conference on Changes in the Chemistry of Lakes Erie and Ontario. Bull. Buffalo Soc. Nat. Sci. Buffalo, N. Y. 25(2): 31-64.

The concentrations of chemicals in the two lakes are compared. The three categories discussed and compared are: nutrients; major ions; and trace elements.

94. Chawla, Vinod K. and Y. K. Chau. 1969. Trace elements in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 760-765.

The data on trace elements obtained from six cruises during the period June to October 1967 on Lake Erie were examined to study their concentrations and distributions both horizontally and vertically.

Of the 11 elements studied, the concentrations of cadmium, chromium and cobalt were below the detection limits. The annual average values of iron, manganese, strontium and copper of surface waters were comparatively higher than the average of some fresh water lakes of North America. Concentrations of zinc, nickel, lithium and lead were quite comparable.

The horizontal distributions of copper, zinc, nickel, lithium and lead were uniform in the main water body of the Western, Central and Eastern Basins. Iron and manganese were higher in the Western and Central than the Eastern Basins, however, strontium on the contrary was lower in the Western Basin.

95. Chawla, Vinod K. and W. J. Traversy. 1968. Methods of analysis on Great Lakes waters. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 524-531.

Methods of the Analytical Section, Water Quality Division, were used to analyze Great Lakes waters aboard ship on Lake Erie and at the shore based laboratory, Burlington, Ontario where both Lake Erie and Lake Ontario waters were analyzed.

Lake Erie samples were analyzed aboard ship for pH, turbidity, dissolved oxygen, biochemical oxygen demand, specific conductance, silica, nitrate and orthophosphate. The analyses carried out on shore included sulphate, chloride, alkalinity, calcium, magnesium, sodium, potassium, fluoride and many heavy metals. This paper discusses some techniques and limitations, particularly, for determining orthophosphate aboard ship. It tabulates the methods used for determining each parameter and shows the precision for these methods obtained on shore.

96. Ciaccio, Leonard L., Raul R. Cardenas, Jr. and John S. Jeris. 1973. Automated and instrumental methods in water analysis. In: Leonard L. Ciaccio (Ed.), Water and Water Pollution Handbook. Marcel Dekker, Inc. New York, N. Y. 4: 1479 p.

Many pollutants as well as naturally occurring organic materials will absorb radiation in the ultraviolet portion of the optical spectrum. Using this principle, Bramer et al have recently developed an instrument for continuously monitoring raw and finished waters spectrophotometrically. By use of such instrumentation they were able to detect phenol, pyridine, and benzene at concentrations of 10-50 ppb. An application of such instrumentation has been in the continuous monitoring of the surface waters of Lakes Erie and Ontario, thus allowing a rapid detection of zones of pollution. More recently, a patent has been granted to H. H. Seward for a water quality monitor employing an ultraviolet detector.

97. Clark, Clarence F. 1956. Sandusky River report. Ohio Div. Wildlife. Columbus, Ohio. 67 p. + maps.

Pollution as it causes the absence of fish is discussed. NSQCD

Clay, Edythe I. - See: Bernard S. Meyer, et al, No. 231.

Colby, Peter J. - See: Henry F. Lucas, Jr., et al, No. 217.

98. Colby, Peter J., G. R. Spangler, D. A. Hurley and A. M. McMombie. 1972. Effects of eutrophication on Salmonid Communities in oligotrophic lakes. J. Fish. Res. Bd. Canada. 29(6):975-983.

Increased nutrient loads and subsequent increased plant production result in alterations in the abiotic environment, including changes in the color and transparency of the water, increased turbidity, oxygen depletion in the hypolimnion, and

increased chemical stratification. The physico-chemical changes precipitate biotic changes among the phytoplankton, littoral algae, zooplankton, and benthos. The salmonid community may respond initially with an increased body growth rate in various taxa and a higher incidence of parasitism, but later inhibition of natural reproduction occurs, and finally, the taxa are replaced by others that can survive in the changed environment.

A relation between natural nutrient loading (expressed in terms of a morphoedaphic index) and yield (both quantitative and qualitative) is proposed as an aid to determining the natural successional status of a lake.

Compton, Billy - See: Gunther Zweig, No. 382.

99. Cooke, G. Dennis (Ed.). 1969. The Cuyahoga River Watershed. Proceedings of a symposium held at Kent State University, Nov. 1, 1968. Kent State Univ. Inst. Limnology. Dept. Biol. Sci. 143 p.

This report presents the content of an interdisciplinary watershed symposium. Information presented includes the watershed area as an ecological unit, the environmental geology, and the basin as a socio-economic unit. The second section concerns water quality, including chemical and biological data. A panel discussion sums up the diverse aspects of the conference.

100. Copeland, Richard. 1970. The mercury threat: Questions to consider. Limnos. 3(2):11-13.

Western Lake Erie has mercury readings ranging between 500-2000 ppb. Two industrial users, Dow Chemical and Wyandotte, are the largest contributors of contaminants to Lakes St. Clair and Erie. They averaged 50 pounds/day from 1950 to 1970. In the elemental form, mercury would not enter the environment; however, certain mud-dwelling bacteria are capable of converting it into methyl mercury. The organic mercury then enters the food chain.

Cowell, Bruce C. - See: Jacob Verduin, et al, No. 359.

101. Curl, Herbert Charles, Jr. 1953. A study of distribution of phosphorus in Western Lake Erie and its utilization by natural phytoplankton populations. In: Lake Erie Pollution Survey. Ohio Dept. Nat. Resources. Div. Water. Columbus, Ohio. Final Rept. pp. 133-136.

Numerous studies have been made in attempts to elicit the role that phosphorus plays in the production of living matter, especially in aquatic situations. The sources of phosphorus for Lake Erie are three: that which already exists in the water at a given moment, that which is brought in from the tributaries, and that which is derived from resuspended sediment. The water in the basin is a mixture from several sources that have radically different phosphorus contents.

102. Curl, Herbert Charles, Jr. 1959. The origin and distribution of phosphorus in Western Lake Erie. Limnology and Oceanography. 4:66-76.

The phosphate phosphorus distribution in Western Lake Erie in May 1951 and the average concentration throughout 1950-1951 are shown to be a result of the drift current pattern and discharge of the Maumee and Detroit Rivers. The bedrock in the lake appears to provide negligible quantities. The Detroit River supplies 405 metric tons per year at an average concentration of 2.6 μg PO_4-P/l and the Maumee River supplies 125 tons at an average concentration of 43 μg PO_4-P/l. The remaining streams supply 39 tons at a concentration of 16 μg PO_4-P/l. There is a loss of soluble phosphorus possible as precipitating ferric phosphate and by adsorption into ferric hydroxide. The bottom sediments are considerably enriched in phosphate. Turbidity and phosphate phosphorus in the lake are positively correlated ($r = +0.65$), and evidence from turbidity data indicates that the lake is enriched by a thin-layer tongue of water from the south shore streams which flow over or under the clearer, nutrient-poor water, and then mixes vertically with it. Although phosphorus is probably never limiting in the southern waters of Western Lake Erie, the accompanying turbidity sometimes prevents any significant phytoplankton growth. (BU)

Curnow, R. D. - See: R. D. Hoffman, No. 166.

Curtis, Lamont W. - See: George D. Simpson, et al, No. 295.

103. Cutler, N. L. 1929. The biological investigations of pollution in the Erie-Niagara watershed. In: A Biological Survey of the Erie-Niagara System. Supplement 18th Ann. Rept. (1928). N. Y. Cons. Dept. pp. 134-149.

The biological investigations of the conditions of pollution in the Erie-Niagara watershed were divided into, (1) Lake Erie and Niagara River, and (2) streams. In a biological

study of a lake bottom it is harder to define the three characteristic pollution zones that are usually found in stream studies, i.e. (a) zone of recent pollution, (b) septic zone, (c) zone of recovery. In an open body of water such as Lake Erie a septic zone is never developed due to the rapid dispersion of the polluting substances though areas confined, as by a breakwater, may approach this condition.

104. Dambach, Charles A. 1969. Changes in the biology of the lower Great Lakes. In: Robert A. Sweeney (Ed.), Proceedings of the Conference on Changes in the Biota of Lakes Erie and Ontario. Bull. Buffalo Soc. Nat. Sci. Buffalo, N. Y. 25(1): 1-17.

The dead lake description applied to Lake Erie originated in observations concerning low dissolved oxygen concentrations revealed in synoptic surveys in August, 1964, when an area of about 2,600 square miles (25% of the entire lake) was found to have dissolved oxygen concentrations of 2.0 mg/l or less. It should be noted, however, that low dissolved oxygen concentrations were recorded as early as 1929, and a low value of 0.8 mg/l was measured at one station near Marble Head, Ohio, in August, 1930. The assumption is that low dissolved oxygen is related to lake enrichment and to the biological oxygen demand consequent to decay of plant material in areas where lake stratification occurs as in the Central Basin.

Nutrient concentrations in Lake Erie, notably soluble phosphate values in the Western Basin, consistently exceeded the stated critical value during studies of 1963 and 1964, with average concentrations ranging from 0.005 to 0.15 mg/l of phosphate (PO_4). The Central and Eastern Basins now have phosphate concentrations at the critical threshold value (0.3 mg/l for inorganic nitrogen and 0.03 mg/l for soluble phosphate).

105. Daniels, S. L., L. L. Kemp, E. S. Graham and A. M. Beeton. 1963. Quantitation of microorganic compounds in water of the Great Lakes by adsorption on activated carbon. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:118-123.

Basic data is of value in research on pollutional and limnological characteristics of natural waters. The distribution and concentrations of particular compounds, such as pesticides

and organic nutrients, are matters of national concern. The extremely low concentrations in which these compounds sometimes occur make them difficult to detect by ordinary chemical analysis of water samples. These concentrations are often expressed in parts per billion (ppb) by weight. One method by which the substances can be concentrated for subsequent analysis is adsorption onto activated carbon. Unfortunately, these and similar studies have not clearly resolved questions regarding qualitative and quantitative aspects of the adsorption and subsequent recovery of specific organic compounds. During the study reported in this paper, the types and amounts of materials adsorbed have been found to vary among samples taken both along the shores and in the open waters of certain of the Great Lakes; seasonal differences have also been observed. (RL)

106. Davies, Tudor T. (Ed.). Undated. Proceedings of the First Federal Conference on the Great Lakes, Dec. 13-15, 1972. Prepared by the Env. Protection Agency for the Interagency Committee on Mar. Sci. and Eng. for the Federal Council for Sci. and Technology. 334 p.

The conference was concerned with the exposition and discussion of federal programs in marine science and engineering affecting the Great Lakes. During the meeting, short presentations were given by federal representatives of various international and federal coordinating and scientific groups. These included presentations by the Council on Environmental Quality, International Joint Commission, Great Lakes Fisheries Commission, and International Association of Great Lakes Research. The Secretary of the Interagency Committee on Marine Science and Technology reviewed the origin of the conference and possible alternative objectives. A further overview and evaluation of the effectiveness of the Great Lakes federal programs was provided by an ad-hoc presentation from the General Accounting Office, which reviewed their ongoing evaluation of Great Lakes research.

107. Davis, Charles C. 1953. Cleveland Harbor industrial pollution study. In: Lake Erie Pollution Survey - Final Report. Ohio Dept. Nat. Resources. Div. Water. Columbus, Ohio. pp. 170-188.

In the Cleveland area, the major portion of the industrial effluents are dumped into the Cuyahoga River, though other portions are carried through municipal sewage disposal plants, and are dumped after treatment into Lake Erie at several

points. The present report deals primarily with Cuyahoga River effluents.

108. Davis, Charles C. 1961. The biotic community in the Great Lakes with respect to pollution. Proc. Conf. on Water Pollution and the Great Lakes. DePaul Univ. Chicago, Ill. pp. 80-87.

A general article describing biological change as a result of pollution of lake water.

109. Davis, Charles C. 1962. The plankton of the Cleveland harbor area of Lake Erie in 1956-1957. Ecol. Mono. 32:209-247.

Because the concentrations of chemicals can affect biological systems, specific parameters were monitored during the study, i.e. alkalinity, phosphates, silica, and temperature.

110. Davis, Charles C. 1966. Biological research in the Central Basin of Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:18-26.

The article discusses the shortage of oxygen in relation to the fish, benthic, and planktonic organisms.

111. Davis, Charles C. 1969. Lake Erie's shore and water. In: G. Dennis Cooke (Ed.), The Cuyahoga River Watershed. Proceedings of a symposium held at Kent State University, Nov. 1, 1968. Kent State Univ. Inst. Limnology. Dept. Biol. Sci. pp. 121-134.

The article discusses Lake Erie as a body of water receiving human wastes as well as a confusion of organic and inorganic industrial wastes and plant nutrients and other minerals which are the fillers used in industrial and household detergents.

112. Davis, Charles C. and E. Bennette Henson. 1966. Plankton studies in the largest Great Lakes in the world, with special reference to the St. Lawrence Great Lakes of North America, and a review of Great Lakes benthos research. Univ. Mich. Great Lakes Res. Div. Pub. 14: 54 p.

The chemistry of the lake water which affects plankton and

benthic growth rate is discussed. NSQCD

Devendorf, Earl - See: Hayse H. Black, No. 38.

D'Itri, Frank M. - See: C. S. Annett, et al, No. 10.

D'Itri, Frank M. - See: Ronald J. Evans, No. 124.

Dobson, Hugh H. - See: M. Gilbertson, et al, No. 132.

113. Dobson, Hugh H. and Michael Gilbertson. 1971. Oxygen depletion in the hypolimnion of the Central Basin of Lake Erie, 1929 to 1970. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 743-748.

Evidence is provided for the progressive eutrophication of Lake Erie. Historic records of dissolved oxygen in the hypolimnion were collected and an average depletion rate was established for each year.

The present depletion rate (3.6 mg/l/mo) is more than double the rate estimated for 1929. The rate of deoxygenation has increased at the approximate annual rate of .075 mg/l/mo/yr due to increases in phytoplankton production.

114. Dobson, Hugh H. and Michael Gilbertson. 1972. Oxygen depletion in the hypolimnion of the Central Basin of Lake Erie, 1929 to 1970. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo. U. S. Env. Protection Agency. Washington, D. C. Tech. Rept. TS-05-71-208-24. pp. 3-8.

Evidence is provided for the progressive eutrophication of Lake Erie. Historic records of dissolved oxygen in the hypolimnion were collected and an average depletion rate was established for each year. The present depletion rate (3.6 mg/l/mo) is more than double the rate estimated for 1929. The rate of deoxygenation has increased at the approximate annual rate of .075 mg/l/mo/yr in large part due to increases in phytoplankton production caused by increased nutrient inputs.

115. Dostal, Kenneth A. and Gordon G. Robeck. 1966. Studies of modifications in treatment of Lake Erie Water. J. Am. Water Works Assoc. 58(11):148-1504.

Chemical characteristics of Lake Erie water were monitored. The ranges of pH, temperature, hardness, alkalinity, turbid-

ity, and algae content encountered in the raw water during each of the four seasons are reported. The temperatures varied from 34° to 69° F; turbidity from 2 to 58 Jackson units. Hardness and alkalinity were fairly consistent throughout the study.

Duchene, J. - See: R. M. Pfister, et al, No. 264.

116. Dugal, L. C. 1968. Pesticide residue in freshwater fish oils and meals. J. Fish. Res. Bd. Canada. 25(1):169-172.

The pesticide residue for sheepshead (Aplodinotus grunniens) for Lake Erie was assayed. The concentrations of heptachlor, heptachlor epoxide, DDE, DDT, DDD, and dieldrin in the meals and oils resulting from the rendering operations were determined by gas and thin-layer chromatography. The meals and the oils were also screened for lindane, endrine, and methoxychlor but none of these residues was found. The results of analysis showed that DDT and its metabolites accounted for almost all of the pesticide residues in meals and oils.

Dugan, Patrick R. - See: David L. Howard, et al, No. 168.

Dugan, Patrick R. - See: Walter O. Leshniowsky, et al, No. 210.

Dugan, Patrick R. - See: R. M. Pfister, et al, No. 264.

Duka, B. J. - See: D. Liu, et al, No. 213.

Duryea, R. D. - See: R. D. MacNish, et al, No. 219.

Edgington, David N. - See: Henry F. Lucas, Jr., et al, No. 217.

Edgington, David N. - See: M. M. Thommes, et al, No. 313.

Edmondson, W. T. - See: A. M. Beeton, No. 34.

Eichelberger, J. W., Jr. - See: A. W. Breidenbach, et al, No. 47.

Elrick, D. E. - See: L. R. Webber, No. 365.

117. Environmental Control Technology Corporation. 1974. Huron River: Geddes Dam through Ford Lake - September 12-13, 1973. Mich. Dept. Nat. Resources.

Bureau Water Management. Water Resources Comm. Ann Arbor, Mich. 51 p.

A forty-eight hour intensive study of the Huron River was performed during the month of September, 1973. The primary objectives of the study were: (1) to predict the concentration of chemical constituents for which specific state water quality standards are set at seven days once in the ten year drought flow; and (2) to determine the waste assimilative capacity of the study section of the Huron River. The study included analysis of wastewater point sources discharging directly into the reach of the river under investigation.

118. Erie County Department of Health. 1970. Stream survey, 1970. Erie County Health Dept. Buffalo, N. Y. 93 p. + maps.

Chemical data are available for all the streams in the county. Samples were taken during June, July, and August. Stream violations are enumerated.

119. Erie County Laboratory. 1974. 1973 Erie County stream survey. Erie County Public Health Div. Buffalo, N. Y. 294 p.

The survey program has three main objectives: (1) to determine if the streams are in violation of N. Y. S. standards; (2) to ascertain the source of the pollution; and (3) to study the benthic organisms as they relate to stream quality. General chemical data on the streams flowing into the lake are presented. A separate section deals with the chemicals found as industrial pollutants.

120. Erie-Niagara Basin Regional Water Resources Planning Board. 1969. Erie-Niagara Basin Comprehensive Water Resources Plan. Main Rept. N. Y. Water Resources Comm. Erie-Niagara Basin Regional Planning Bd. Albany, N. Y. 201 p.

This report presents a comprehensive plan for water management and development in the Erie-Niagara Basin. It summarizes investigations which identified available resources and opportunities for development. Alternatives have been evaluated. The report formulates: (1) the alternatives available to meet the needs for municipal and industrial water supply, water quality management, irrigated agriculture, water-oriented recreation, fish and wildlife enhancement, flood plain management; and (2) integrates these alternatives into a co-

ordinated development program for the period 1970 to 2020, with emphasis on the early action (1970-1980) phase of the program. NSQCD

121. Erie and Niagara Counties Regional Planning Board. 1969. Catalog of resource materials. Erie and Niagara Counties Regional Planning Bd. Grand Island, N. Y. 114 p.

This catalog contains the joint holdings of papers, reports, and articles of the Erie and Niagara Counties Regional Planning Board and the Society for the Promotion, Unification and Redevelopment of Niagara, Incorporated (SPUR). The catalog is divided into thirty-three categories and then subdivided into seven subcategories, by geographical location.

122. Erie and Niagara Counties Regional Planning Board. 1973. Environmental assessment statement for the regional water quality management study. Erie and Niagara Counties Regional Planning Bd. Utilities Committee. Grand Island, N. Y. 337 p. + map.

This publication is an overview of existing conditions. The information presented is divided into sections: (1) political responsibility for water management; (2) the economic history of the area; (3) current wastewater treatment facilities; and (4) how each town obtains its fresh water. Throughout, there are recommendations for ways in which to accomplish water management goals.

123. Erie and Niagara Counties Regional Planning Board. 1973. Environmental assessment statement for the regional water quality management study. Erie and Niagara Counties Regional Planning Bd. Utilities Committee. Grand Island, N. Y. 273 p. + Appendices A-G.

For each of the watersheds discussed, a summary of sanitary sewage plans is given, the adopted plan is described, and the recommended plan is detailed (if it differs from the adopted plan). A section is devoted to the description of the environmental impacts of the alternative sanitary sewage plan. The alternative sanitary sewage plans are summarized. NSQCD

124. Evans, Ronald J., Jack D. Bails and Frank M. D'Itri. 1972. Mercury levels in muscle tissues of preserved museum fish. Env. Sci. and Tech. 6(10): 901-905.

Flameless atomic absorption spectrophotometry was used to establish the total mercury levels in 57 preserved fish specimens collected in the Lake St. Clair-Western Lake Erie region of the Great Lakes between the years of 1920-65. Only five fish were found to contain mercury levels in excess of 0.5 ppm--three large muskellunge collected in Lake St. Clair in 1939 (2.38, 1.57, and 1,58 ppm) and two adult sea lampreys collected in the Clinton River tributary to Lake St. Clair in 1938 (0.90 and 1.29 ppm). A trend was established relating the mercury content of selected categories of fishes with the year and location of collection for the fish specimens. The 1970-71 mercury levels in fish from the two study areas were found to average more than those preserved museum specimens in the same categories taken from the same area.

Fadow, M. P. - See: C. S. Annett, et al, No. 10.

Farragut, Robert N. - See: Mary H. Thompson, No. 314.

125. Fimreite, N., W. N. Holsworth, J. A. Keith, P. A. Pearce and I. M. Gruchy. 1971. Mercury in fish and fish-eating birds near sites of industrial contamination in Canada. Canadian Field-Naturalist. 85(3): 211-220.

The mercury residue from Lake Erie walleye (Stizostedion v. vitreum) is reported in a table.

Finsterwalder, Charles C. - See: Richard L. Carr, et al, No. 85.

126. Fish, Charles J. 1929. Preliminary report on the cooperative survey of Lake Erie, season of 1928. Bull. Buffalo Soc. Nat. Sci. Buffalo, N. Y. 14(3):7-16, 195-220.

As a result of more than five hundred analyses made, it is possible to safely say that the lake as a whole is remarkably free from pollution. In harbors and along the shore in places the water is often badly polluted, but these are purely local problems and affect in no way the lake as a whole. The churning action in the shallow water about the margin of Lake Erie, which is choppy most of the time, aerates the water and in the presence of sunlight dilutes and quickly eliminates waste products. At Dunkirk the area within the breakwater was badly polluted, the bacterial count being almost beyond computation, and the water absolutely devoid of oxygen. However, a quarter of a mile off the mouth of the harbor the water con-

tained an abundance of oxygen and was without a detectable trace of pollution of any sort. The oft repeated statement that industrial waste from the Detroit River and the cities at the western end of the lake is invading the eastern area and destroying the fishing is without foundation. Nowhere in the open lake was objectionable pollution of any kind found in the water or silt deposits located on the bottom.

127. Fish, Charles J. 1929. A preliminary report on the joint survey of Lake Erie. In: A Biological Survey of the Erie-Niagara System. N. Y. Cons. Dept. Albany, N. Y. Supplement to 18th Ann. Rept. (1928). pp. 39-44.

Chemical observations included the following: free ammonia; albuminoid ammonia; nitrates; dissolved oxygen; dissolved carbon dioxide; calcium carbonate; calcium bicarbonate; and hydrogen ion test to determine the normal chemistry of the lake and the extent and concentration of pollution.

128. Fish, Charles J. and Associates (Eds.). 1960. Limnological Survey of Eastern and Central Lake Erie 1928-1929. U. S. Fish and Wildlife Service. Washington, D. C. Spec. Sci. Rept. - Fish. No. 334. 198 p.

Results of a cooperative survey of the Central and Eastern Basins of Lake Erie in 1928-29 are presented. Physicochemical data include seasonal, vertical, and horizontal variations in temperatures, water movements, dissolved oxygen, carbon dioxide, phenolphthalein and methyl-orange alkalinity, pH, chlorides, and turbidity. The species composition, seasonal abundance, and distribution of micro- and macroplankton are discussed in detail. Special consideration is given to the influence of polluted river waters which flow into the lake.

It is concluded that the lake is remarkably free from chemical and sewage pollution. Evidence of pollution farther than 1 mile from possible sources was detected at only 2 stations. The nutrient level of Lake Erie is high and the lake should support large fish populations.

Frea, James I. - See: David L. Howard, et al, No. 67, 68.

Frea, James I. - See: Walter O. Leshniowsky, et al, No. 210.

Frea, James I. - See: Gail E. Mallard, No. 221.

Frea, James I. - See: Patricia A. McCabe, No. 224.

Frea, James I. - See: R. M. Pfister, et al, No. 264.

129. Frenette, Roger E. 1971. A water quality management strategy for the Great Lakes. Cornell Univ. Water Resources and Mar. Sci. Center. Ithaca, N. Y. Tech. Rept. 34. 221 p.

A major reason for severe water pollution problems in the lower Great Lakes is due to the lack of an effective plan or stragegy to manage water pollution. This report concerns methodology, the planning task, problem identification, description, and value formulation. A discussion of alternatives and their evaluation completes this presentation. Federal Water Pollution Control Administration chemical data is given.

130. Frost, S. L. 1965. Water is life: Lake Erie pollution survey. Ohio Cons. Bull. (March). pp. 14-15, 21.

According to Mr. H. W. Poston, pollution in Lake Erie is coming from two major sources: (1) the debris of civilization washed off the surface by rain, especially during the first flush of runoff; and (2) overflows of sewage and storm flows of treatment plants. NSQCD

131. Fruh, E. Gus, Kenton M. Stewart, Fred G. Lee and Gerald A. Rohlich. 1966. Measures of eutrophication and trends. J. Water Poll. Control Federation. 38(8):1237-1258.

Various chemical, physical, and biological measurements were used to determine the relative state and rate of eutrophication. At the present time, there is no single determination that is a universal measure of eutrophication. Until more is known about eutrophication, nutrients from natural, agricultural, and urban drainage as well as from wastewater effluents should be kept to a minimum by sound conservation practices, tributary and lake zoning, careful water quality surveillance, and education of the public.

Gilbertson, Michael - See: Hugh H. Dobson, No. 113, 114.

132. Gilbertson, Michael, Hugh H. Dobson and T. R. Lee. 1972. Phosphorus and hypolimnial dissolved oxygen in Lake Erie. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo. U. S. Env. Protection Agency. Washington, D. C. Tech. Rept. TS-05-71-208-24. pp. 141-145.

The International Joint Commission has proposed specific water quality objectives for Lake Erie which would involve the reduction of phosphorus loadings. A proposal is made to limit the input of phosphorus to Lake Erie to a level which would prevent nuisance growths of algae, weeds, and slime which are or may become injurious to any beneficial water use. This limitation would not be total but would occur in stages.

Glooschenko, Walter A. - See: A. S. Menon, et al, No. 227, 228.

133. Glooschenko, Walter A. 1971. The effect of DDT and dieldrin upon C^{14} uptake by *in situ* phytoplankton in Lakes Erie and Ontario. *Internat*. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 219-223.

In situ studies were performed upon the effects of DDT and dieldrin to phytoplankton in Lake Ontario in May 1970 and Lake Erie in July and October 1970. To water samples, concentrations of 1, 10, 100 and 1000 ppb DDT and dieldrin (Lake Erie only) were added. The response of the phytoplankton was measured by C^{14} uptake over five-hour intervals.

The inhibition of C^{14} uptake by DDT and dieldrin does not appear to be important to the Great Lakes *in situ* except possibly in local areas of high run-off from agricultural sources. The major problem appears to be concentration of these pesticides by algae and transfer to higher trophic levels.

134. Glooschenko, Walter A., H. F. Nicholson and J. E. Moore. 1973. Surface distribution of total chlorophyll *a* in Lakes Ontario and Erie, 1970. Fish. Res. Bd. Canada. Burlington, Ont. Tech. Rept. 351. 25 p.

An investigation was made to determine the relative distribution of surface chlorophyll *a* in Lake Erie with particular emphasis upon temporal and spatial distribution. The greatest difference between the Western Basin and the other basins occurred during July and late August. This difference was perhaps related to the development of blue-green algal blooms. The annual mean ratio of chlorophyll *a* between the Eastern, Central, and Western Basins was 1 : 1.3 : 2.1 respectively.

135. Gotaas, Harold B. 1969. Outwitting the patient assassin: The human use of lake pollution. Bull. Atomic Scientists (May). pp. 8-10.

Water pollution problems today center on: the fish and wildlife of the country; the recreational uses of natural resources; the chemical and biological quality of the waters; and, the desire for a more satisfactory environment. However, an alternate approach such as seeding desirable fish and re-establishing commercial fishing on the Great Lakes may offer a more promising and less costly way to restore biological balance in the lakes.

136. Gottschall, Russell Y. 1930. Preliminary report on the phytoplankton and pollution in Presque Isle Bay, Lake Erie. Proc. Pa. Acad. Sci. 4:69-74.

The waters of Presque Isle Bay and vicinity are contaminated with sewage from the city of Erie. No evidence to date has been found of anaerobic respiration or a low enough oxygen content which would not support life. The lowest O_2 content (41%) was found in September, while the highest was complete saturation in January.

137. Goulden, P. D. and B. K. Afghan. 1970. An automated method for determining mercury in water. Canada Dept. Energy, Mines and Resources. Inland Waters Branch. Ottawa, Ont. Tech. Bull. 27. 21 p.

Of all the water samples obtained throughout Canada, the mercury content in almost all samples has been in the range 0 to 10 µg/l and the technique described here has been adequate to determine that content. It involves the oxidation of organo-mercury compounds by ultra-violet irradiation followed by the reduction of the mercury to the elemental state. The mercury is swept out of the solution by a stream of air and its concentration measured in an absorption cell in an atomic absorption spectrophotometer. For levels of mercury in the range 1.0 to 32 µg/l the method has been automated to measure 20 samples per hour. For levels of mercury in the range 0.05 to 1.0 µg/l only 10 samples per hour can be processed because a longer sampling time is required.

Graham, E. S. - See: S. L. Daniels, et al, No. 105.

Graves, Robert C. - See: Brian E. Melin, No. 226.

Gray, C. B. J. - See: A. L. W. Kemp, et al, No. 189.

138. Gray, C. B. J. and A. L. W. Kemp. 1970. A quantitative method for the determination of chlorin pigments in Great Lakes sediment. Internat. Assoc.

Great Lakes Res. Proc. 13th Conf. Great Lakes Res. pp. 242-249.

A method for the extraction and quantitative measurement of chlorophylls a, b, c; pheophytin a, b; chlorophyllides a, b; pheophorbides a, b; and allomerized a and b chlorin pigments in the lake sediments is described. The chlorin pigments are ultrasonically extracted in an acetone-methanol mixture, concentrated, and separated by reverse-phase thin layer chromatography. The chlorins were eluted from each band and determined spectrophotometrically. The method had a precision of ± 6%.

Chlorin pigments were determined in six surface sediment samples from the main basins of Lakes Ontario and Erie. Chlorophyll a (0-10 ppm), allomerized chlorophyll a (0-1.3 ppm), pheophytin a (3.6-7.4 ppm) and pheophorbide a (6.7-17.3 ppm) were found in the six samples. The absence of chlorophyll b and its degradation products suggested that the organic material at these stations was autochthonous organic matter.

139. Great Lakes Basin Commission. 1969. Great Lakes Basin Library Interim Bibliography. Great Lakes Basin Comm. Ann Arbor, Mich. 257 p.

This annotated bibliography, the first volume of which was issued January 1969, is arranged alphabetically by issuing agency and contains a listing of the documents and reports processed by the library.

140. Great Lakes Basin Commission. 1969. Great Lakes Basin Library Interim Bibliography II. Great Lakes Basin Comm. Ann Arbor, Mich. 440 p.

This annotated bibliography, a companion volume to the first interim bibliography issued January 1969, lists the same collection of documents and reports as well as the ones received between January and April.

141. Great Lakes Commission. 1966. Water quality management in the Great Lakes states and Ontario. Great Lakes Comm. Inst. Sci. and Technology. Ann Arbor, Mich. 58 p.

The possibility of pure water through enacted legislation is discussed and statements about water quality are presented. NSQCD

142. Great Lakes Institute. 1964. Great Lakes Institute Data Record - 1962 Surveys. Part I: Lake Ontario and Lake Erie. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. PR 16. 97 p.

The data in this report represent the physical, chemical and meteorological information collected during the 1962 research cruise of the Porte Dauphine.

143. Great Lakes Institute. 1965. Annual Report - 1964. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. PR 18. 47 p.

This report describes the activities of the Institute during the year, lists the cruises and scientists conducting research, and describes the type of data collected. NSQCD

144. Great Lakes Institute. 1965. Great Lakes Institute Data Record - 1963 Surveys. Part I: Lake Ontario, Lake Erie, and Lake St. Clair. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. PR 23. 195 p.

Physical and chemical data on lake waters and the meteorological conditions which accompanied each survey are presented.

145. Great Lakes Institute. 1968. Annual Report - 1967. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. PR 31. 70 p.

Six different cruises of Lake Erie were undertaken during the year which monitored water quality conditions. NSQCD

146. Great Lakes Institute. 1969. Annual Report - 1968. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. PR 35. 42 p.

The report contains a listing of the personnel, graduate students, and publications of the scientific staff. During the year, four survey cruises of Lake Erie were undertaken to collect water samples for laboratory analysis. NSQCD

147. Great Lakes Institute. 1970. Annual Report - 1969. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. PR 40. 31 p.

The report includes a listing of Council members, Advisory Board members, Associates, support staff, and graduate stu-

dents. One monitoring survey of Lake Erie was completed during the year. NSQCD

148. Great Lakes Institute. 1971. Great Lakes Institute Data Record Surveys in 1964 of the CCGS Porte Dauphine for Lake Ontario, Lake Erie, Lake St. Clair, Lake Huron, Georgian Bay and Lake Superior. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. PR 42. 238 p.

The data consist entirely of physical and chemical data on lake waters and the meteorological conditions which accompanied the survey. Monthly lakewide surveys constituted the basic observational program during the navigation season.

149. Great Lakes Institute. 1972. Annual Report - 1971. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Rept. EG 4. 25 p.

During the year, the research division undertook one survey of Lake Erie to collect water samples for analysis. NSQCD

150. Great Lakes Research Institute. 1971. The Lake Erie Congress: Proceedings of the First Session, July 12-14, 1971. Great Lakes Res. Inst. Erie, Pa. 42 p.

This article outlines the areas of committee interest into social aspects of the environment and economic-industrial issues. Various resolutions are suggested to curb the problem. NSQCD

151. Great Lakes Research Institute. 1973. Annual Report - 1972-73. Great Lakes Res. Inst. Inst. Env. Sci. and Eng. Erie, Pa. 122 p.

The report consisted of proposed water projects and completed limnological studies. NSQCD

152. Great Lakes Research Institute. 1973. Selected analysis and monitoring of Lake Erie water quality. Univ. Toronto. Great Lakes Res. Inst. Toronto, Ont. Ann. Rept. and Supplement. 60 p. and 136 p.

The annual report contains the data accumulated during the year. The supplement contains a statistical analysis of the data. Samples were collected from April 30 to September 21. In all, 1,541 pieces of data were analyzed for 22 selected responses.

Green, R. S. - See: A. W. Breidenbach, et al, No. 46.

153. Gross, M. Grant. 1971. The pollution of the coastal ocean and the Great Lakes. U. S. Naval Inst. Proc. Naval Rev. 97(819):228-243.

Lake Erie has received large volumes of wastes and shows the greatest eutrophication. Total dissolved solid concentrations are high; phosphates and nitrates are abundant and support large growths of phytoplankton. NSQCD

Gruchy, I. M. - See: N. Fimreite, No. 125.

154. Grundy, Richard D. 1971. Strategies for control of man-made eutrophication. Env. Sci. and Tech. 5(12):1184-1190.

Controlling phosphorus alone and detergent phosphates, in particular, may retard cultural eutrophication where phosphorus limits aquatic productivity. However, long-term control strategies must reflect regional variations in limiting nutrients and other factors contributing to aquatic productivity. Regional variations are experienced in the contributions of nutrients entering the aquatic environment from municipal waste water, urban runoff, agricultural runoff from fertilized fields and livestock feedlots, and erosion. Agricultural runoff exhibits large seasonal variations.

155. Gumerman, R. C. 1970. Aqueous phosphate and lake sediment interaction. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. pp. 673-682.

Significance of aqueous phosphate interaction with sterile sediment from Central Lake Erie and Western Lake Superior was investigated in the laboratory. The buffering effects of sediments upon aqueous phosphate is of critical significance in attempts to alter lakewater phosphate concentration. System equilibrium shifts to yield greater removal at increased aqueous phosphate concentration, oxidation-reduction potential, and acid pH values. However, decreased uptake per unit weight af sediment results from both decreased temperature and depth of sediment greater than 3.5 mm below the interface.

Gunnerson, Charles G. - See: A. W. Breidenbach, et al, No. 46.

Gunnerson, Charles G. - See: Leo Weaver, et al, No. 364.

156. Gustafson, Philip F. 1970. Future levels of tritium in the Great Lakes from nuclear power production. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. pp. 839-843.

A variable input of tritium into Lake Erie may arise from the nuclear fuel reprocessing plant at West Valley, New York; however, due to uncertainties as to source strength, this input is not considered in the annual input to Lake Erie. To a first approximation, the equilibrium value of tritium build-up in a given lake system is a function of the rate of tritium input and the rate of water loss from the system. This explains the apparent disparity, for example, between Lake Huron and Lake Erie. Lake Huron has only three times the tritium input of Lake Erie, yet has 15 times the tritium build-up at equilibrium due to the appreciably larger water loss (on a percent of volume basis rate for Erie).

Gutenmann, Walter H. - See: Raymond J. Lovett, et al, No. 214.

Hamilton, A. L. - See: R. O. Brinkhurst, et al, No. 49.

157. Harlow, George L. 1966. Major sources of nutrients for algal growth in Western Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:389-394.

Municipal wastes from Southeast Michigan are the greatest sources of nitrogen and phosphates contributed to the Michigan waters of Lake Erie. In Southeast Michigan, land runoff plays a minor role in the contribution of nitrogen and phosphates to Lake Erie. The contribution of nitrogen from land runoff plays a greater role toward lake enrichment than the phosphates from land drainage.

The Detroit River is the largest single source of nutrients to Lake Erie, contributing 107,500 tons per year of total nitrogen and 47,000 tons per year of total phosphates. All other sources of these nutrients from Southeast Michigan contribute 1,200 tons per year of phosphates and 1,020 tons per year of total nitrogen. Onshore sources of nutrients in Southeast Michigan contribute 33,230 tons per year of total phosphates and 17,660 tons per year of total nitrogen.

Phosphates from the Maumee River affect the water quality in the southwest corner of Lake Erie. Phosphate and nitrogen compounds are very pronounced in Lake Erie near the debouchment of the Detroit River, and nearshore concentrations of

nitrogen and phosphates in the lake are greater than those in deeper water. Concentrations of nitrogen and phosphates in Michigan Lake Erie exceed the levels required to trigger algal blooms during the spring growing season.

Harris, A. J. - See: J. R. Vallentyne, et al, No. 347.

Harris, C. R. - See: J. R. W. Miles, No. 234.

Harris, Earl J. - See: Raymond J. Lovett, et al, No. 214.

Harris, Earl J. - See: Irene S. Pakkala, et al, No. 260, 261.

Hartman, Wilbur L. - See: H. A. Reiger, No. 273.

158. Hartman, Wilbur L. 1970. Resource crises in Lake Erie. Explorer. 12(1):6-11.

The various chemicals which affect fish habitats are discussed. NSQCD

159. Hartman, Wilbur L. 1972. Lake Erie: Effects of exploitation, environmental changes, and new species on the fishery resources. J. Fish. Res. Bd. Canada. 29(6):899-912.

In no other lake as large as Lake Erie (surface area, 25,690 km^2) have such extensive changes taken place in the drainage basin, the lake environment, and the fish populations over the last 100 years. Deforestation and prairie burning led to erosion and siltation of valuable spawning grounds. Marsh spawning areas were drained. Lake-to-river spawning migrations were blocked by mill dams. Accelerated cultural nutrient loading increased total dissolved solids by nearly 50% (1920-70). Average summer water temperatures increased 1.1° C. Phytoplankton and zooplankton abundance increased severalfold. Severe oxygen depletion developed in the bottom waters of all three basins of the lake. Lake sturgeon were fished out as nuisance fish in the late 1800's. The commercial fisheries for lake trout, lake whitefish, and lake herring collapsed by 1940 and those for blue pike and walleye by 1960. Yellow perch production became unstable in the 1960's. The effects of exploitation, environmental changes, and new species on these fish population changes are discussed.

160. Hartman, Wilbur L. 1973. Effects of exploitation, environmental changes, and new species on the fish

habitats and resources of Lake Erie. Great Lakes Fish. Comm. Ann Arbor, Mich. Tech. Rept. 22. 43 p.

No other lake as large as Lake Erie (surface area, 25,690 km^2) has been subjected to such extensive changes in the drainage basin, the lake environment, and the fish populations over the last 150 years. Deforestation and prairie burning led to erosion of the watershed and siltation of valuable spawning grounds. Marsh spawning areas were drained. Lake-to-river spawning migrations of sturgeon, walleye, and other fishes were blocked by mill dams. Accelerated cultural nutrient loading increased total dissolved solids by nearly 50% (1920-70). Phosphate loading reached 469 metric tons per year by the 1950's and continued to increase. The biomass of phytoplankton increased 20-fold between 1919 and 1963. Oxygen demand for decomposition of these algae so degraded oxygen regimes in the Western and Central Basins by the 1950's that the once abundant mayfly nymphs were destroyed and the Central Basin hypolimnion became anoxic.

Hartt, James P. - See: John M. Winner, No. 376.

161. Hayes, F. R. 1963. Chemical characteristics of fresh water. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10: 112-117.

Triple regression analysis was applied to lakes of North America. Lake Erie demonstrated the greatest deviation between observed and calculated PI. The first chemical test on a lake is relative hardness; other measurements include conductivity, concentration of Ca or Mg, and residue on evaporation. The equations permit conversion of other records to alkalinity. Conductivity and molar sum of Ca or Mg provide the closest alternatives to a methyl orange titration.

Heath, R. C. - See: R. D. MacNish, et al, No. 219.

Henke, C. F. - See: A. W. Breidenbach, et al, No. 47.

Henson, E. Bennette - See: Charles C. Davis, No. 112.

Herbes, Stephen E. - See: James R. Kramer, et al, No. 199.

Herdendorf, Charles E. - See: Lester J. Walters, Jr., et al, No. 361, 362.

162. Herdendorf, Charles E. 1969. Water masses and their movements in Western Lake Erie. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 74. 7 p.

Water samples were analyzed within three days of the survey for the following properties: turbidity; hydrogen-ion concentration (pH); and specific conductance. Temperature and conductivity were measured at five-foot depth intervals from surface to bottom, at quarter-mile intervals at the Detroit River mouth, and at mile intervals in the lake. The river profile shows three distinct water masses. Water with higher temperature and greater conductivity occupied the shallower areas along the east and west shores; the midchannel flow was cooler and lower in conductivity. The lake profile indicates that five zones or water masses were present south of the river mouth: it appears that midchannel flow divided upon entering the lake and was separated by Western Basin water with higher conductivity.

163. Herdendorf, Charles E. 1970. Lake Erie physical limnology cruise, midsummer 1967. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. Rept. Invest. 79. 77 p.

The cruise was undertaken to provide new information on the physical limnology of Lake Erie, with particular attention to circulation patterns and to changes that occur in the quality of the water as it passes through the lake. The objective of the field survey was to measure several physicochemical properties of Lake Erie water from its major inflow at the Detroit River to outflow in the Niagara River. The properties and conditions investigated on the cruise were: water temperature; specific conductance; water color; transparency; hydrogen-ion concentration (pH); dissolved-oxygen content; chloride-ion concentration; turbidity; currents; waves; water level; meteorological conditions; water depth; and bottom deposits. The study was completed within a two-week period to give the data collected some degree of synopticity.

Herrington, H. B. - See: R. O. Brinkhurst, et al. No. 49.

Hetling, Leo J. - See: Patricia Boulton, No. 45.

164. Hile, Ralph. 1966. U. S. Federal research on fisheries and limnology in the Great Lakes through 1964: An annotated bibliography. U. S. Fish

and Wildlife Service. Bureau Commercial Fish. Spec. Sci. Rept. - Fish. No. 528. 53 p.

The annotated bibliography is preceded by a brief account of the Federal research program in fisheries and limnology in the Great Lakes in 1957-64. 314 papers by staff members of the Bureau of Commercial Fisheries and 35 by associated scientists are covered.

165. Hill, Gladwin. 1965. The great and dirty lakes. Saturday Review. 18:32-34.

The article is a general discussion of how pollution and depletion have ruined a great water resource. NSQCD

166. Hoffman, R. D. and R. D. Curnow. 1973. Toxic heavy metals in Lake Erie herons. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 50-53.

Great blue herons (Ardea herodias), black-crowned night herons (Nycticorax nycticorax) and American egrets (Casmerodius albus) of the southwestern Lake Erie region were collected and assayed for toxic metals concentrations. During August and September 1972, eleven great blue herons, eight black-crowned night herons and six American egrets were collected from island and mainland heronries and marshlands in the Oak Harbor-Port Clinton, Ohio vicinity. Tissue samples from adult, juvenile and nestling birds included breat muscle, brain and liver. Primary wing feathers were also collected from adult and juvenile birds. Concentrations of mercury, cadmium and lead were determined by atomic absorption spectrophotometry. Mercury concentration levels differed between bird species, location of collection, and age.

Holsworth, W. N. - See: N. Fimreite, No. 125.

Horst, Thomas J. - See: Frank J. Little, et al, No. 212.

167. Howard, David L., James I. Frea and Robert M. Pfister. 1971. The potential for methane-carbon cycling in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 236-240.

Biological methane production and oxidation were studied by in situ methods in the Western Basin of Lake Erie and in the laboratory by isolated cultures obtained from the lake. Rates of methane production in situ were constant over sediment

covered areas at 1.71 cc methane/min/m^2 of sediment bottom and no production over areas devoid of sediments. Two gram negative bacilli capable of producing methane in a simple salts medium containing $CaCO_3$ and H_2 were isolated several times during the summer months of 1970. Determinations of in situ methane oxidation in sediment covered areas by 50 cc samples of lake water indicated oxidation rates of 0 in the upper 2 m of the water column and up to 8.8 μg/5 days at the 4 m depth. Two methane oxidizing bacteria were isolated from the lowest meter of the water column and the surface of sediments, but no methane oxidation or isolates could be obtained by in situ methane oxidation and by isolated cultures.

168. Howard, David L., James I. Frea, Robert M. Pfister and Patrick R. Dugan. 1970. Biological nitrogen fixation in Lake Erie. Science. 169(3940):61-62.

Biological nitrogen fixation, as determined by acetylene reduction, occurs in Lake Erie. Fixation potential by blue-green algae in situ in water and by bacteria in collected sediments was demonstrated. Nitrogen-fixing activity occurred from June through November suggesting that it is significant over the extremes of seasonal variation in light, temperature, and nutrients.

169. Hufford, Terry L. 1965. A comparison of photosynthetic yields in the Maumee River, Steidtmann's Pond, and Urschel's Quarry under natural conditions. Ohio J. Sci. 65(4):176-182.

A study of photosynthetic rates under natural conditions in the Maumee River, Steidtmann's Pond, and Urschel's Quarry, computed from pH and O_2 measurements in the natural habitat at 4- to 6-hour intervals, revealed average rates of 1.4 to 20.9 μmol CO_2 absorbed per liter of water per hour, and 0.27 to 1.32 μmol CO_2 absorbed per μliter of plant matter per hour, with 0.1 to 35.0 μmol O_2 evolved per liter of water per hour, and about 0.012 to 2.22 μmol O_2 evolved per μliter of plant matter per hour. These values lie within the range of values for ponds, quarries, lakes, and streams reported in the literature. They are much lower than published values for clear flowing streams. It seems likely that poor light supplies resulting from suspended silt particles cancel any ecological advantage the turbulence of flowing water might provide. The ratios of O_2 production to CO_2 absorption were close to unity except during the spring flood period when ratios below 0.1 were observed, similar to ratios found in a shallow pond near Bowling Green.

170. Hunt, George S. 1961. Waterfowl losses on the lower Detroit River due to oil pollution. Univ. Mich. Great Lakes Res. Div. Proc. 4th Conf. on Great Lakes Res. Pub. 7:10-26.

The effects of oil pollution on waterfowl are described. A number of ways are suggested to reduce the losses of waterfowl due to oil pollution. Most of them do not appear feasible for one reason or another. The use of boats, aircraft, loud noises, and flares to frighten the ducks from the danger area is probably workable. The most sensible way to pare oil induced mortality is to reduce drastically the amount and frequency of oil flows.

171. Hunt, George S. 1967. Wild celery in the lower Detroit River. Ecology. 44(2):360-370.

As a control for research on plant growth, various chemical parameters were monitored. Changes have occurred during the past 20 years in the approximate localities where this information was gathered. The International Joint Commission data gathered during 1946 to 1948 indicate: (1) dissolved oxygen, 4.9 to 15.0 ppm, generally above 8.0 ppm, minimum 65% saturation, usually near saturation; (2) pH, 7.2 to 8.2 , average 7.7; (3) alkalinity, 71 to 94 ppm, average 80 ppm; (4) ammonia as N_2, maximum 0.50 ppm; (5) chloride, maximum 85 ppm; (6) turbidity, 0.5 to 46.0 ppm, average 15 to 20 ppm; (7) temperature, low of 32.1° F in winter to 83.3° F in summer. A decrease in dissolved oxygen and increase in nitrogenous materials and chloride indicate an increase in pollution.

Hurley, D. A. - See: P. J. Colby, et al, No. 98.

Hyche, C. M. - See: K. K. S. Pillay, et al, No. 265.

172. Hydroscience, Inc. 1973. Limnological systems analysis of the Great Lakes, Phase I. Preliminary model design. Prepared for the Great Lakes Basin Comm. Westwood, N. J. 474 p.

Lake Erie chemical data is included in the table of Great Lakes water sampling data summary. All of the sources for data on the lake are included in the report. When evaluating the availability of past and present water quality data for the lakes, attention was focused on those sources whose data were collected over large areas of the lake or whose records extended over long periods of time.

173. International Joint Commission. 1951. Report of the International Joint Commission United States and Canada on the pollution of boundary waters. Internat. Joint Comm. Washington, D. C. 312 p.

The analytical results from the 1913 investigations are given, as well as the current findings. The water quality standards for international waters are listed and the need for pollution control programs is emphasized. The pollution problems are discussed, and the need for identification, sources, health aspects, remedial measures, and costs are commented upon. (BECPL)

174. International Joint Commission. 1969. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River. Internat. Joint Comm. Internat. Lake Erie Water Poll. Bd. Washington, D. C. Summary. Vol. 1. 151 p.

The report details the pollution and eutrophic conditions. Water quality objectives are defined and the various remedial measures with their estimated costs are discussed. The existing international cooperating agencies and legislative plans are elucidated.

175. International Joint Commission. 1969. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River. Internat. Joint Comm. Internat. Lake Erie Water Poll. Bd. Washington, D. C. Lake Erie. Vol. 2. 316 p.

This report contains data on all aspects of the pollution problem. Tables present information gathered from research and engineering sources. An effort has been made to forecast developing problems. The concluding section contains recommendations for necessary remedial measures.

176. International Joint Commission. 1969. Potential oil pollution incidents from oil and gas well activities in Lake Erie, their prevention and control. Internat. Joint Comm. Internat. Lake Erie Water Poll. Bd. Washington, D. C. 163 p.

The content of the report is concerned with the following: (1) the adequacy of existing safety regulations; (2) the adequacy of current methods for controlling oil spills; and (3) the adequacy of existing contingency plans and the actions taken to implement them to confine and clean up transboundary

pollution and to prevent or mitigate the destructive effects of any major oil spills from sources in Lake Erie.

177. International Joint Commission. 1970. Pollution of Lake Erie, Lake Ontario and the International Section of the St. Lawrence River. Internat. Joint Comm. Washington, D. C. 174 p.

The report details the extent of the pollution problem in terms of the biological aspects, current sources, and potential oil hazard. Jurisdictional and legal problems are considered in the discussion. A series of recommendations and remedial measures conclude the presentation.

178. International Joint Commission. 1972. Great Lakes Water Quality Agreement between the United States of America and Canada. Internat. Joint Comm. Washington, D. C. 69 p.

The report contains the specifications of water quality standards. The programs for control of phosphorus are outlined and each type of polluting material is defined. Other points discussed are: vessel wastes; studies of pollution from shipping sources; identification and disposal of polluted dredge spoil. The joint contingency plan and the plan for further research on pollution from land sources are presented.

179. International Joint Commission. 1973. Great Lakes water quality annual report to the International Joint Commission. Internat. Joint Comm. Internat. Great Lakes Water Quality Bd. Washington, D. C. 315 p.

The report includes Lake Erie as it details the pollution and the sources for it throughout the Great Lakes. Water quality legislation for each area of the Great Lakes is enumerated. The extent to which each locality is complying with existing laws is mentioned.

180. International Joint Commission. 1973. Report on Great Lakes water quality for 1972. Internat. Joint Comm. Washington, D. C. 30 p.

In this annual report, the conclusions and recommendations are concerned primarily with the governmental actions needed to enable the Commission and the various jurisdictions in each country to carry out their responsibilities. A summary of U. S. and Canadian pollution abatement measures and policies is included. NSQCD

181. International Joint Commission. 1973. Semi-annual report. Internat. Joint Comm. Res. Advisory Bd. Washington, D. C. 23 p.

This report includes: a review of research activities concerned with and applicable to the quality of the waters of the Great Lakes; recommendations to the International Joint Commission concerning research needs; and a specific list of the areas of interest of each committee member. NSQCD

182. International Joint Commission. 1974. Detailed study plan to assess Great Lakes pollution from land use activities. Internat. Joint Comm. Great Lakes Water Quality Bd. Land Drainage Reference Group. Washington, D. C. 81 p. + 50 p. Appendices.

The report proposes studies on the effects of land use activities upon water quality. An inventory of land use and land use practices and a series of studies on representative watersheds will provide information for predicting the effect on the Great Lakes. NSQCD

183. International Joint Commission. 1974. Great Lakes water quality: Second annual report. Internat. Joint Comm. Internat. Great Lakes Water Quality Bd. Washington, D. C. 115 p.

On the basis of available information, the Board concludes that the water quality of Lake Erie generally has not changed significantly from 1970 to 1973. There are, however, some definite signs of improvements in certain previously defined problem areas. Baseline water quality investigations are in progress as part of the reference study.

Jackson, William B. - See: Lester J. Walters, Jr., et al, No. 361.

184. Jenne, E. A. 1972. Mercury in waters of the United States: 1970-71. U. S. Geol. Surv. Water Resources Div. Washington, D. C. 24 p.

Two tributaries of Lake Erie, the Black and Maumee Rivers, were assayed for mercury content.

Jeris, John S. - See: Leonard L. Ciaccio, et al, No. 96.

Johnson, L. E. - See: R. D. MacNish, et al, No. 219.

Johnson, W. E. - See: J. R. Vallentyne, et al, No. 347.

Jones, David L. - See: Charles F. Powers, et al, No. 271.

185. Kantz, Paul, Jr. (Ed.). 1970. The environmental problems of the Lake Erie Basin. John Carroll Univ. Lake Erie Conf. Carroll Business Bull. Spec. Issue. 10(1): 36 p.

The bulletin contains a general discussion about the chemicals found in Lake Erie waters. The sources of the various kinds of chemicals are described. Some solutions to the pollution problem are mentioned.

Kawahara, F. K. - See: A. W. Breidenbach, et al, No. 46.

186. Keating, William F. 1969. A federal view of water pollution control. Env. Control Management. (November). pp. 19-23, 40.

The federal government's involvement with pollution control is detailed in this interview with David Dominick. NSQCD

Kee, D. A. - See: C. R. Ownbey, No. 259.

Keith, J. A. - See: N. Fimreite, et al, No. 125.

Keller, Myrl - See: John F. Carr, et al, No. 84.

Kemp, A. L. W. - See: C. B. J. Gray, No. 138.

187. Kemp, A. L. W. 1969. Organic matter in the sediments of Lakes Ontario and Erie. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. Great Lakes Res. pp. 237-297.

Organic carbon and carbonate carbon were determined in six piston cores from Lake Ontario and four piston cores from Lake Erie. The changes in organic carbon with depth of burial are related to sediment type and Eh. Nitrogen, bitumens, humic acids, fulvic acids and kerogen were measured in three surface sediment samples from each lake.

188. Kemp, A. L. W. 1971. Organic carbon and nitrogen in the surface sediments of Lakes Ontario, Erie and Huron. J. Sed. Petrol. 41(2):537-548.

Analyses of 355 surface sediment samples (top cm) from Lakes

Ontario, Erie and Huron were carried out for organic carbon, carbonate carbon, Eh, pH, nitrogen and sediment texture. Similar analyses were carried out on a representative core from each lake at close intervals down to 20 cm. The distribution of organic matter in the sediments of each lake was related to the topographic features of the lakes. Organic carbon content was found to be directly proportional to the clay content of the sediment, ranging from less than 1 percent in the coarse nearshore sands to over 4 percent in the fine clay muds within the individual lake sub-basins. The organic carbon content of Lake Erie sediments was generally lower than that of Lakes Huron and Ontario, and is attributed to dilution of the sediments with coarser non-clay particles. Nitrogen was directly proportional to organic carbon with carbon-nitrogen ratios ranging from 7 to 13 in the surface sediment. Organic carbon and nitrogen decreased sharply from the surface down to about 10 cm in each core. The decrease is due partly to mineralization of organic matter by bottom organisms and partly to an increasing input of organic matter to the lakes in the last 30 years.

189. Kemp, A. L. W., C. B. J. Gray and Alena Mudrochova. 1972. Changes in C, N, P, and S in the last 140 years in three cores from Lakes Ontario, Erie, and Huron. In: H. E. Allen and James R. Kramer (Eds.), *Nutrients in Natural Waters*. John Wiley and Sons. New York, N. Y. pp. 251-279.

The results of this study relate the maximum OC, CC, N, P, and S values in the surface sediments with the concentrations at the Ambrosia horizon. The values of OC, N, and P have increased about threefold in the Erie core, suggesting a threefold increase of loading to the sediments. The increases in OC and N in the Ontario and Erie cores parallel the increase in dissolved solids to the two lakes. The increase commenced in about 1900 and seems to be accelerating. Changes in sediment OC and N appear to reflect the increased loading of the Great Lakes, as well as measurements of water quality. Finally, it is concluded that cultural eutrophication of Lakes Ontario and Erie has resulted, so far, in a threefold increase in sediment organic matter, nitrogen, and phosphorus above the natural sediment levels.

190. Kemp, A. L. W. and C. F. M. Lewis. 1968. A preliminary investigation of chlorophyll degradation products in the sediments of Lakes Erie and Ontario. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. Great Lakes Res. pp. 206-229.

Thirty-seven surface sediment samples from Lakes Erie and Ontario have been examined for acetone-soluble chlorophyll degradation products, from stations generally distributed along the axes of the two lakes. Determinations were made for chlorophylls, pheophytins, organic carbon, carbonate carbon, Eh, pH and particle size distribution.

Kemp, L. L. - See: S. L. Daniels, et al, No. 105.

Kennedy, R. - See: R. M. Pfister, et al, No. 264.

191. Kettaneh, Anthony (Ed.). 1971. Troubled waters, Lake Erie. U. S. National Tech. Info. Service. Lake Erie Congress. Great Lakes Res. Inst. Erie, Pa. 121 p.

The amounts of minor elements in Lake Erie vary considerably at different locations, the amount being, in general, significantly higher near population centers. The Western Basin contains much higher amounts of some elements than the lake overall. The various chemicals which can be dissolved in water are discussed for their effect on the lake's ecological system.

192. Kisicki, Donald Robert. 1973. Environmental management of the Great Lakes international boundary areas: A case study of the Niagara urban region. N. Y. S. Sea Grant Program. Great Lakes Management Problem Ser. Albany, N. Y. 301 p.

The lack of water quality as it affects economic growth is detailed in the presentation. The agencies responsible for the maintenance of clean water in each area are listed. NSQCD

Koner, Robert C. - See: John F. Kopp, No. 193.

193. Kopp, John F. and Robert C. Koner (Eds.). 1967. Trace metals in waters of the United States: A five year summary of trace metals in rivers and lakes of the United States, October 1962-September 1967. Federal Water Poll. Control Admin. Div. Poll. Surveillance. Cincinnati, Ohio. 32 p. + Appendices A-P.

Three major rivers empty into Lake Erie; two of these, the Maumee and Cuyahoga, are included in the Water Quality Surveillance System. The Maumee River at Toledo has relatively high summer temperatures, high levels of dissolved phosphate

and hard water, all of which favor a rich and diverse plankton flora. In contrast, the water of the Cuyahoga River at Cleveland supports very low plankton population. This may be due to low phosphate levels although zinc is often present at this station in concentrations known to inhibit algal growth.

The high zinc concentration in the Cuyahoga resulted in a large mean value for the Lake Erie Basin. The same was true for boron and manganese. Strontium generally was observed at higher levels in the Maumee. The Lake Erie Basin had a higher frequency of detection as well as a higher mean nickel value than the national averages. Again, this was a result of the nickel observed in the Cuyahoga.

Kovacik, Thomas L. - See: Lester J. Walters, Jr., et al, No. 361, 362.

194. Kovacik, Thomas L. and Lester J. Walters, Jr. 1973. Mercury distribution in sediment cores from Western Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 252-259.

Mercury analyses of 63 sediment cores located on a five-minute latitude-longitude grid from Western Lake Erie indicate that two general sources, background and pollution, contribute to the mercury content of sediments in Lake Erie. A background mercury concentration of 0.04-0.09 ppm was observed below about 15 cm for most cores. A constant background level was observed throughout nine of the cores. This background level of mercury, which is similar to that in the Canadian source areas, results from erosion and transport of sediment to Lake Erie. Data indicate that no change has occurred in the background mercury levels until modern time.

Modern sediments at most of the sampling stations exhibit a surface enrichment zone of 1-4 ppm, which decreases exponentially with depth to the background level. The authors believe that this surface enrichment zone is the result of mercury pollution from chloralkali plants and coal fly ash during the time of man's influence. The highest level of surface mercury enrichment (4 ppm) in the Western Basin is southwest of the mouth of the Detroit River, while the lowest level is around the Bass Islands. The distribution of mercury throughout the Western Basin is directly related to the flow patterns of Detroit River water into the basin. In some areas, resuspension and redeposition of sediment from the surface enriched zone due to current action results in abnormally high mercury

levels that are homogenous in the top 20 cm of sediment. Approximately 25% of the sediment cores showed evidence of this resuspension and redeposition process.

Kramer, Jack W. - See: David B. Baker, No. 19.

195. Kramer, James R. 1961. Chemistry of Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 4th Conf. on Great Lakes Res. Pub. 7:27-56.

Because Lake Erie has shown many biological changes in the past half century and these changes may reflect chemical changes, two synoptic cruises were planned to obtain virtually complete chemical data both in area and depth.

One might suspect that bottom sediments are important in determining chemical concentration. Further, Lake Erie is small in volume, borders on large population areas, and therefore pollution (chemical contributions other than from nature) effects, if present, should be readily detectable. The river-like nature of Lake Erie should also aid in flushing chemical constituents that are not fixed biologically or in sediments, and indirectly chemical processes could be discerned by elimination.

196. Kramer, James R. 1967. Chemistry of Lakes Erie and Ontario: Assuming a Gibbsian thermodynamic world. In: Systems approach to water quality in the Great Lakes. Proc. 3rd Ann. Sym. on Water Resources Res. Ohio State Univ. Columbus, Ohio. pp. 27-36. Reprinted in: Univ. Mich. Great Lakes Res. Div. Collected Reprints. 2:168-176.

Within the total inorganic-organic system, normally natural processes approach a reversible inorganic equilibrium state with respect to solids, liquid, and gases. Equilibrium calculations are therefore a means to define a "norm" or water criteria standard. The measurements and calculations to define this norm are simple in most cases.

Deviations from the norm are influenced by complicated (and in most cases, unknown) organic processes as long as there is some equivalency between variables in the calculations of the norm and the complicated organic processes.

Engineering management may be undertaken by manipulating "simple" inorganic variables common to both inorganic and organic mechanisms. The manipulation of the variables should be con-

sidered first in an inorganic context.

197. Kramer, James R. 1968. Mineral water chemistry. Univ. Mich. Great Lakes Res. Div. Ann Arbor, Mich. Spec. Rept. 38. 59 p.

The computer program uses major and minor ion concentrations to determine the degree of saturation of lake water with respect to $CaCO_3$, $CaMg(CO_3)$, $Ca_{10}(PO_4)_6(OH)_2$, air, oxygen, carbon dioxide, and various aluminosilicates. Factor analysis of combined chemical and biological data for Lake Erie shows it to be fundamentally an oxygen deficient, CO_2 excess body of water, suggesting major pollution reactions are of the type--carbon wastes + O_2 = CO_2. Water is saturated with respect to hydroxyapatite during the summer months, but phosphate is removed after the lake overturns in the fall.

198. Kramer, James R. 1968. Mineral-water equilibria in silicate weathering. In: 23rd Internat. Geol. Congress. 6:149-160.
Reprinted in: Univ. Mich. Great Lakes Res. Div. Collected Reprints. 2:177-188.

The silicate weathering process is quite different for a limestone terrane compared to a silicate rock terrane. In a silicate terrane, a simple dissolution process forming kaolinite (and eventually gibbsite) appears to take place. If there are excess cations and alkalinity as represented by carbonate rock terranes, clay minerals intermediate to feldspars and kaolinite will form. Amorphous silica should form in the interstitial waters in many sedimentary environments during weathering.

Low pH, high $P\text{-}CO_2$, low alkalinity, and low cation concentrations tend fo form only dissolution products and kaolinite. High pH, high alkalinity, low $P\text{-}CO_2$, and low H_4SiO_4 concentrations tend to form chlorite, kaolinite, and montmorillonites. This is the typical reaction. High pH, high alkalinity, low $P\text{-}CO_2$, and high H_4SiO_4 concentrations would favor the formation of illite.

It is probable that montmorillonites are metastable in a geological sense, and they may alter to feldspars, kaolinite, or chlorite. No doubt the cation content of montmorillonites is a marked function of the cation concentration of the water which in turn may reflect the composition of the surrounding rock. Therefore similar studies in iron, magnesium, and calcium rich silicate rocks is desirable.

199. Kramer, James R., Stephen E. Herbes and Herbert E. Allen. 1972. Phosphorus: Analysis of water, biomass and sediment. In: H. E. Allen and J. R. Kramer (Eds.), Nutrients in Natural Waters. Wiley-Interscience. New York, N. Y. pp. 51-100.

Lake Erie is detailed as an example of the phosphorus equilibria process.

200. Kramer, James R. and G. Keith Rodgers. 1968. Natural processes and water quality control. In: Proceedings of Great Lakes Water Resources Conference, June 24-26. Eng. Inst. Canada and Am. Soc. Civil Engr. pp. 419-431.

Lake Erie as it compares with the other Great Lakes is discussed in terms of the possibility of obtaining desired water quality.

Krammerer, J. C. - See: R. J. Archer, et al, No. 11.

Kupiec, Albert R. - See: Daniel G. Bardarik, et al, No. 21.

201. Lane, Robert K. 1969. Application of remote sensing to pollution studies. In: Proc. 3rd Canadian Sym. on Water Poll. Res. Univ. Toronto. Great Lakes Inst. Toronto, Ont. 3:155-180.
Reprinted in : Canada Centre for Inland Waters. Collected Reprints. Vol. 1.

Gathering data from airborne or orbiting vehicles by measuring emitted or reflected energy is an application of remote sensing. Two of the more common remote sensing techniques are radar and photography. Both techniques rely on the detectability of energy directed at, then reflected from, the target substance. By knowing the reflectivity of important targets at the various wavelengths of energy being measured, target identification may be achieved. In this way, using appropriate wavelengths, radar may be used to locate clouds, or rain within clouds, or aircraft within a rain squall. Or, using the sun as a source, appropriate filters may be used to determine the spectral characteristics of reflected solar radiation and relate them to the nature of the reflecting target.

Large scale aspects of lake pollution involving the inflow, dispersion, circulation and outflow of polluted waters are closely related to physical characteristics and processes.
NSQCD

202. Langlois, Thomas H. 1964. Lake Erie: Progress towards disaster. In: J. R. Dymond (Ed.), Fish and Wildlife. Longmans Canada, Limited. Toronto, Ont. 9 p.

The southern part of the western end has shown ageing more than the rest of the lake, with notable increases in the free ammonia, nitrites, nitrates, total nitrogen, and total phosphorus. There have been changes too in the impounded mouths of the tributary streams, with silt smothering out the leafy aquatic vegetation and thus allowing the exit of more silt out of these bays into the lake. NSQCD

203. Langlois, Thomas H. 1967. Lake Erie despoiled. Echoes. Ohio Historical Soc. Columbus, Ohio. 6(90):1.

The article clarifies some of the reasons for concern about the quality of water in Lake Erie. NSQCD

LaSala, A. M., Jr. - See: R. J. Archer, et al, No. 11.

204. LaSala, A. M., Jr. 1968. Ground-water resources of the Erie-Niagara Basin, New York. N. Y. Cons. Dept. Water Resources Comm. Erie-Niagara Basin Regional Water Resources Planning Bd. Grand Island, N. Y. *Basin Planning Rept.* ENB-3. 114 p.

The principal water-bearing formations in the area are: glacial sand and gravel deposits; the Camillus Shale, which contains interbedded gypsum; a limestone aquifer unit consisting of the Onondaga Limestone, Akron Dolomite, and Bertie Limestone; and the Lockport Dolomite. A number of thick and permeable sand and gravel deposits lie in the valleys of the upland region and will yield supplies of 500-1,400 gpm to individual wells that are properly constructed. The Camillus Shale, limestone unit, and Lockport Dolomite vary widely in water-bearing characteristics. (SE)

205. League of Women Voters. 1966. Lake Erie: Requiem or reprieve? League of Women Voters. Lake Erie Basin Committee. Erie, Pa. [illegible] p.

The content is a description of Lake Erie as it related to the economic and social development of the geographical area. NSQCD

Lee, Fred G. - See: Gus E. Fruh, et al, No. 131.

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Lee, T. R. - See: M. Gilbertson, et al, No. 132.

206. Lehman, Jacob W. 1973. Tritium cycling in a Lake Erie marsh ecosystem. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 65-75.

Preliminary results of tritium (^3H) cycling in a Lake Erie march ecosystem are presented. The objective of the research was to determine if bioaccumulation and translocation of tritium occur in a marsh ecosystem. Air, water, water vapor, sediment cores and invertebrate samples were collected from a two-hectare study unit which had been treated with approximately 1 curie of tritium. An exponential loss rate of tritium from the treated water was determined. Tritium loss by evaporation was determined to parallel the loss rate from the water. A possible tritium sink was indicated from the ^3H activities of the sediment cores. Invertebrate samples of two snail species (Viviparus malleatus and Lymnaea exilis) and glass shrimp (Palaemonetes sp.) were analyzed for tritium activity. In general the tritium uptake and loss paralleled the tritium activity in the water, though niche preferences affected these rates. No long-term bioaccumulation of tritium was indicated, but there was an indication of translocation of tritium through the food chain. Further research should indicate more definite trends.

207. Leonard, Justin W. 1962. Environmental requirements of Ephemeroptera. In: Clarence M. Tarzwell (Ed.), Biological Problems in Water Pollution - 3rd Seminar. U. S. Dept. Health, Education and Welfare. Env. Health Ser. Cincinnati, Ohio. pp. 110-117.

A few of the critical chemicals for survival of an organism living in an aquatic environment are described. Some toxic industrial pollutants are discussed. NSQCD

208. Leonard, Richard P. 1972. Assessment of the environmental effects accompanying upland disposal of polluted harbor dredgings, Fairport, Ohio. Cornell Aeronautical Lab., Inc. Buffalo, N. Y. CAL Rept. No. NC-5191-M-1. 42 p.

Data is collected to discern the effect on the environment when Lake Erie Harbor or Grand River dredgings are used as landfill. The chemical data describe the constituents found in the dredgings.

209. Leonard, Richard P. 1972. Assessment of the environmental effects accompanying upland disposal of polluted harbor dredgings, Ashtabula Harbor, Ohio. Cornell Aeronautical Lab., Inc. Buffalo, N. Y. CAL Rept. No. NC-5191-M-2. 25 p.

Data is collected to discern the effect on the environment when Lake Erie Harbor or Ashtabula River dredgings are used as landfill. The chemical data describe the constituents found in the dredgings.

210. Leshniowsky, Walter O., Patrick R. Dugan, Robert M. Pfister, James I. Frea and Chester I. Randles. 1970. Adsorption of chlorinated hydrocarbon pesticides by microbial floc and lake sediment and its ecological implication. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. Great Lakes Res. pp. 611-618.

Of thirty-eight aerobic bacteria isolated from Lake Erie, 14 formed flocs in at least one of six different media used. Two of these floc formers were examined for ability to accumulate aldrin from solution. Aldrin (10^{-6}g/ml) was dissolved in acetone and added to flasks containing pregrown bacterial flocs suspended in water. Flocs were shaken for various time intervals and separated from solution by centrifugation. Both were analyzed separately for presence of aldrin using gas liquid chromatography.

Contemporary sediment collected from Lake Erie was examined microscopically, analyzed for pesticide content and ability to adsorb aldrin. Bacterial flocs adsorbed aldrin from solution giving a 625X concentration factor within 20 min after which there was no further increase. The collected sediment behaved similarly.

Floc forming microbes settling from a water column remove pesticides and represent a natural purification process. The pesticides may then accumulate in bottom sediments and exert a toxic effect on susceptible fauna.

211. LesStrang, Jacques (Ed.). 1972. The situation lake by lake. *Limnos*. 5(1):22-23.

In Lake Erie the effects of pollution are extreme: a mat of algae two feet thick and a few hundred square miles in extent floats in the middle of the lake in mid-summer, oxygen levels in areas of the lake bottom are reduced to zero, displacement

of indigenous fish populations by scavenger and trash fish is widespread. Discharge of untreated sewage from combined sewers has compelled the closing of most beaches on the lake. The area of lake bottom where regeneration takes place--the zone of zero oxygen--is spreading, bringing the threat that eutrophication will soon become self-sustaining, unless adequate phosphorus reduction programs can be implemented.

Lewis, C. F. M. - See: A. L. W. Kemp, No. 190.

Lichtenberg, James J. - See: A. W. Breidenbach, et al, No. 46, 47.

Lichtenberg, James J. - See: Leo Weaver, et al, No. 364.

Lisk, Donald J. - See: Raymond J. Lovett, et al, No. 214.

Lisk, Donald J. - See: Irene S. Pakkala, et al, No. 260, 261.

212. Little, Frank J., Jr., Glen F. Bieber, Thomas J. Horst and Danley F. Brown. 1973. Possible accelerated eutrophication thresholds in the Great Lakes relative to human population density. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. Great Lakes Res. pp. 926-933.

Great Lakes data of the 1800's through the mid-1960's were examined using elementary correlation, regression and simple observation. Data included populations, available chemical variables (chloride, total dissolved solids, sulfate and calcium) and fisheries (more sensitive, i.e., trout, whitefish and cisco). Population/km^2 at mean depth yields: (1) highly significant ($r = 0.94, 0.84, 0.87, 0.74$, respectively) and more consistent results than population with respect to surface area or volume; (2) a suggestive and significant all-lakes (less Lake Superior) model closely matched by Erie only; and (3) inspectionally apparent lower value data "tails" suggesting inflection regions and slope changes, herein designated accelerated eutrophication thresholds (AET). Additionally, AET's presumed on inspection of fishery records agree well as to concentration level among themselves and originally suggested AET's. Lumped and averaged fishery chemoconcentration AET estimates and separate subregressions yield a lumped "95% confident interval" mean AET estimate of 157 ± 41 people resident in a given drainage basin/km^2 at mean-depth of that lake basin.

It is inferred that such conservative variables may well pro-

vide better predictors (reflectors) than those currently of primary interest. Should later work substantiate it, this coherent and reasonable image may prove highly significant and contribute strongly toward real ecological engineering.

213. Liu, D., P. T. S. Wong and B. J. Duka. 1973. Determination of carbohydrate in lake sediment by a modified phenol-sulfuric acid method. In: Water Research. 7(5):741-746.
Reprinted in: Canada Centre for Inland Waters. Collected Reprints. Vol. 5. Reprint 5-31.

A spectrophotometric method for the assay of carbohydrates in lake sediments and soil is described that is based on the measurement of color development in phenol-sulfuric acid at 455 nm. The method is more sensitive than the previously used proximate method and consumes less time. The spectrophotometric procedure is therefore advantageous as only a minute quantity of sample (2-50 mg) is required for the carbohydrate determination.

214. Lovett, Raymond J., Walter H. Gutenmann, Irene S. Pakkala, William D. Youngs, Donald J. Lisk, G. E. Burdick and E. J. Harris. 1972. A survey of the total cadmium content of 406 fish from 49 New York State fresh waters. J. Fish. Res. Bd. Canada. 29(9):1283-1290.

Of the total number of fish analyzed, 68.5% contained 20 ppb or less of cadmium. From waters in which at least five fish were netted, levels of cadmium above 20 ppb were found in fish from 12 lakes -- Blue Mountain, Butterfield, Champlain, Erie, Fourth, George, Hemlock, Long, Ontario, Placid, Pleasant, and Raquette -- 2 rivers -- Hudson and St. Lawrence -- and Cattaraugus Creek. Cadmium concentrations above 100 ppb were found in only one fish from each of Lakes Erie, Fourth, and Piseco, and in five fish from the Hudson River. Fifty percent of the fish from Adirondack lakes showed cadmium levels above 20 ppb, while only 24% of the fish from all other parts of the State were above this level. The range of cadmium concentrations found in fish from New York waters (10-170 ppb) thus appears comparable to the range (47-200 ppb) reported for Great Lakes fish.

215. Lucas, Allen M. and Nelson A. Thomas. 1971. Sediment oxygen demand in Lake Erie's Central Basin, 1970. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. Great Lakes Res. pp. 781-787.

Sediment oxygen demand (SOD) rates were measured at five locations in Lake Erie's Central Basin in June, August and September 1970. The rates were determined from changes in the dissolved oxygen concentration of water sealed and circulated within black and clear plexiglass chambers imbedded in the lake bottom. SOD rates recorded in June varied from 1.2 to 2.2 gm O_2/m^2/day and were indicative of eutrophic conditions. In August, rates measured during the daylight hours with the clear chamber (0.0 to 0.4 gm O_2/m^2/day) were less than those measured at night with the clear chamber or with the black chamber during the day (0.7 to 1.0 gm O_2/m^2/day). Oxygen produced by the photosynthetic activity of algae on the lake bottom offset the SOD during part of the day resulting in daily SOD rates of 0.4 to 0.7 gm O_2/m^2/day. Rates measured in September with oxygenated surface water trapped and carried to the bottom in the chambers ranged from 1.0 to 2.4 gm O_2/m^2/day.

216. Lucas, Allen M. and Nelson A. Thomas. 1972. Sediment oxygen demand in Lake Erie's Central Basin, 1970. In: Noel M. Burns and Curtis Ross (Eds.), Project Hypo. U. S. Env. Protection Agency. Washington, D. C. Tech. Rept. TS-05-71-208-24. pp. 45-50.

In the Central Basin of Lake Erie, DO depletion does not follow the expected pattern of a gradual DO withdrawal during the entire period of stratification. The SOD does not decrease but increases in late summer to deplete the DO resources of the hypolimnion. Other workers have theorized that this increased demand results from the resuspension of sediments (which can increase oxygen demand by a factor as high as ten) or from the death and decomposition of viable benthic algae.

Lucas, Henry F., Jr. - See: M. M. Thommes, et al, No. 313.

217. Lucas, Henry F., Jr., David N. Edgington and Peter J. Colby. 1970. Concentrations of trace elements in Great Lakes fishes. J. Fish. Res. Bd. Canada. 27(4):677-684.

The concentration of 15 trace elements was determined by activation analysis of samples of whole fish and fish livers from three of the Great Lakes: Michigan; Superior; and Erie. The average concentrations of 7 elements in 19 whole fish from 3 species were as follows: uranium, 3 ppb; thorium, 6 ppb; cobalt, 28 ppb; cadmium, 94 ppb; arsenic, 16 ppb; chromium, 1 ppm; and copper, 1.3 ppm. The average concentrations of

8 elements in 40 liver samples from 10 species of fish were as follows: uranium, ~2 ppb; thorium, ≤2 ppb; cobalt, 40 ppb; copper, 9 ppm; zinc, 30 ppm; bromine, 0.4 ppm; arsenic, 30 ppb; and cadmium, 0.4 ppm. Other elements observed in most of the samples were: antimony, 5-100 ppb; gold, 2-5 ppb; lanthanum, 1-20 ppb; rhenium, 0.5-5 ppb; rubidium, 0.06-4 ppm; and selenium, 0.1-2 ppb.

Trace element concentrations varied with species and lake. Uranium and thorium varied with species, but not for the same species from different lakes. The levels of copper, cobalt, zinc, and bromine varied little between species and lakes. The concentration of cadmium, arsenic, and chromium varied between species and with species between lakes.

218. Luck, Alan D. 1967. Lake Erie--a study in resource geography. M. A. Thesis. Univ. Oklahoma. Norman, Okla. 79 p.

Pollution comes mainly from the large urban complexes flanking Lake Erie, most of which are on the United States side. The increases in population and the expansion of industry are the two basic factors underlying the alarm over the problem of the pollution of Lake Erie. Other contaminants, organic compounds, are becoming more evident in water bodies as a result of the modern chemical revolution. These cause greater concern as technology continues to increase, and they presently include some of Lake Erie's most pronounced contaminants.

219. MacNish, R. D., R. C. Heath, L. E. Johnson, R. A. Wilkens and R. D. Duryea (Eds.). 1969. Bibliography of the ground-water resources of New York through 1967. N. Y. Cons. Dept. Water Resources Comm. Bull. 66. 186 p.

With the growth of population and the increase of pollution of lakes, streams, and aquifers, knowledge of the water-bearing zones below the earth's surface becomes important. This bibliography lists all references concerning water-bearing strata in a single publication.

220. Magno, Paul J., Thomas C. Reavey and John C. Apidianakis. 1972. Iodine-129 in the environment around a nuclear fuel reprocessing plant. U. S. Env. Protection Agency. Washington, D. C. 23 p.

During the first five years of operation of the Nuclear Fuel Services plant, discharges of iodine-129 have resulted in

specific activities of this radionuclide as high as 6.1×10^{-1} $\mu Ci/g$ of iodine in the aqueous environment and 2.8×10^{-1} $\mu Ci/g$ of iodine in the terrestrial environment around the plant. These values are a factor of about 10^4 higher than background levels. Even at a distance of 10 miles from the plant, the iodine-129 specific activity was ten times the background.

221. Mallard, Gail E. and James I. Frea. 1972. Methane production in Lake Erie sediments: Temperature and substrate effects. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. Great Lakes Res. pp. 87-93.

Methane produced in the laboratory by microorganisms in Lake Erie sediment was monitored. The effects of variation in temperature and the addition of various compounds as additional substrate were noted. The incubation temperatures used were 10° C, 28° C and 37° C. The compounds added as additional substrate were hydrogen gas, methanol, ethanol, propanol, butanol, formate, acetate, propionate and butyrate. More methane is produced at 37° C than at 28° C. No methane is produced at 10° C unless the culture is first primed by growth at higher temperatures. Methane production is enhanced by the addition of methanol, acetate, ethanol, propanol, butyrate and hydrogen gas. The addition of butanol, formate and propionate appears to inhibit normal methane production.

Mancy, K. H. - See: H. E. Allen, et al, No. 4.

Marion, C. V. - See: A. S. Menon, et al, No. 229, 230.

222. Marshall, J. S., A. M. Beeton and D. C. Chandler. 1964. Role of zooplankton in the freshwater strontium cycle and influence of dissolved salts. Verh. Internat. Limnol. 15(2):665-672.

The concentrations of chemicals which effect biological organisms were ascertained during the experimental process. Lake Erie water was used to provide more natural conditions for growth. The Sr^{85} content of individual Daphnia magna adults was determined at frequent intervals for a period of more than eight days. Over 95% of an animal's strontium content at equilibrium appears in the exoskeleton which it eliminates upon molting. This was verified by radioassay of the shed exoskeletons.

Matson, W. R. - See: H. E. Allen, et al, No. 4.

Mayer, Titiana - See: J. D. H. Williams, No. 372.

223. Maylath, Ronald E. 1967. Periodic report of the water quality surveillance network - 1965 thru 1967 water years. N. Y. S. Dept. Env. Cons. Albany, N.Y. 390 p.

A table of results from chemical surveys of Lake Erie water is presented.

224. McCabe, Patricia A. and James I. Frea. 1971. Effect of mineral particulates on microbial degradation of solid organic materials. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. on Great Lakes Res. pp. 44-51.

In an aqueous medium, strong interactions occur between mineral particulates and (1) the mycelium of a streptomycete, (2) solid proteinaceous substrates and (3) the extracellular enzyme of the streptomycete. We have demonstrated adherence of kaolin to cell and substrate surfaces. We assayed kaolin-adsorbed enzyme by its ability to release azo dye conjugated to collagen, and to degrade collagen structure. In a cell free system, kaolin-enzyme and kaolin-substrate interaction effects two enhancements of enzyme activity. Adherence of enzyme-coated kaolin to degradable material places the enzyme in immediate contact with substrate.

225. McLean, E. O. 1970. Agricultural pollution of Lake Erie. Ohio Report. 55(4):94.

The Departments of Agronomy and Agricultural Engineering have proposed a field study of the movement of plant nutrients and other agricultural chemicals into lake water.

McMombie, A. M. - See: P. J. Colby, et al, No. 98.

McNair, T. - See: R. M. Pfister, et al, No. 264.

226. Melin, Brian E. and Robert C. Graves. 1971. The water beetles of Miller Blue Hole, Sandusky County, Ohio (Insecta: Coleoptera). Ohio J. Sci. 71(2):73-77.

Chemical parameters which effect biological habitat were monitored during this study.

227. Menon, A. S., W. A. Glooschenko and N. M. Burns. 1972. Bacteria-phytoplankton relationships in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. on Great Lakes Res. pp. 94-101.

Bacterial densities in Lake Erie exhibited two maxima, in August and late October and two minima, in late September and early December. Highest bacterial densities were found in the eutrophic Western Basin and the least in the mesotrophic Eastern Basin. Vertical distribution of bacteria was fairly uniform when the water was unstratified. During summer stratification, hypolimnion bacterial densities increased steadily and reached maximum levels in late August, coinciding with the period of maximum phytoplankton development. A significant positive correlation was found between bacteria, chlorophyll a and particulate organic carbon in the hypolimnion during this period.

Complex bacteria-phytoplankton relationships existed in Lake Erie, of which four types are described in this study. Generally, bacteria appeared to be dependent on the nutrients derived from the excretion and degradation of phytoplankton.

228. Menon, A. S., W. A. Glooschenko and N. M. Burns. 1973. Bacteria-phytoplankton relationships in Lake Erie. In: Internat. Assoc. Great Lakes Res. Proc. 15th Conf. on Great Lakes Res. pp. 94-101. Reprinted in: Canada Centre for Inland Waters. Collected Reprints. Vol. 5.

The results of the present paper indicate that the relationships between bacteria and phytoplankton are complex and tend to vary according to season and environment. In Lake Erie the following relationships between bacteria and phytoplankton were observed: (a) low bacterial densities coincide with high chlorophyll a, (b) high bacterial densities coincide with high chlorophyll a, (c) high bacterial densities coicide with low chlorophyll a and (d) low bacterial densities coincide with low chlorophyll a.

229. Menon, A. S., C. V. Marion and A. N. Miller. 1971. Microbiological studies of oxygen depletion and nutrient regeneration processes in the Lake Erie Central Basin. Internat. Assoc. Great Lakes Res. Proc. 14th Conf. on Great Lakes Res. pp. 768-780.

The significance of bacterial activity in the overall processes of oxygen depletion and nutrient regeneration in the Central Basin of Lake Erie was assessed. Most intensive bacterial activity occurred at the sediment-water interface. Bacterial decomposition of organic matter accumulating at the interface resulted in the formation of reduced products of low molecular weight and depletion of oxygen in the hypolimnion. These compounds were subsequently oxidized by

chemoautotrophic bacteria with further loss of O_2. Reducing conditions on the bottom adversely affected nitrifying bacterial densities. However, actively photosynthesizing algae freshly deposited on the bottom stimulated multiplication of nitrifying bacteria and nitrification.

Large bacterial populations were absent in the thermocline, suggesting that this zone was not a site for intensive bacterial activity. Quantitative analysis indicated that the high bacterial densities in the hypolimnion, especially at the sediment-water interface, respiring at the rate of 2.4×10^{-11}mg O_2/cell/hr could account for oxygen depletion in the lake.

230. Menon, A. S., C. V. Marion and A. N. Miller. 1972. Microbiological studies related to oxygen depletion and nutrient regeneration processes in the Lake Erie Central Basin. In: Noel M. Burns and Curtis Ross (Eds,), Project Hypo. U. S. Env. Protection Agency. Washington, D. C. Tech. Rept. TS-05-71-208-24. pp. 71-84.

The sediment-water interface was found to be the major site of intensive bacterial activity. The organic deposits from the algal rains and other sources which accumulated at the bottom underwent bacterial decomposition resulting in oxygen depletion and the formation of reduced products of low molecular weight. The reduced products were subsequently oxidized by chemoautotrophic bacteria at the sediment-water interface, or in the overlying waters, resulting in additional oxygen depletion. This process repeated itself after each algal rain, causing further loss of oxygen.

Merkle, Henry K. - See: George D. Simpson, et al, No. 295.

231. Meyer, Bernard S., Frank H. Bell, Lawrence C. Thompson and Edythe I. Clay. 1943. Effect of depth of immersion on apparent photosynthesis in submersed vascular aquatics. Ecology. 24(3):393-399.

As a control for research on plant growth, temperature, dissolved oxygen, carbon dioxide, carbonate concentration and pH of the lake were monitored.

232. Michalski, M. F. P. 1972. Phytoplankton conditions in the Nanticoke area of Lake Erie, 1969-1971. Ministry of the Env. Ottawa, Ont. 44 p.

The amount of chlorophyll a and the turbidity of the waters were monitored during biological surveys.

233. Michigan Water Resources Commission. 1970. Great Lakes algae monitoring program, 1969. Mich. Dept. Nat. Resources. Lansing, Mich. 16 p.

Table one lists concentrations of chemicals monitored during 1969 in Lake Erie.

234. Miles, J. R. W. and C. R. Harris. 1971. Insecticide residues in a stream and a controlled drainage system in agricultural areas of Southwestern Ontario, 1970. Pesticide Monitoring J. 5(3):289-294.

A creek flowing into Lake Erie and a controlled drainage system (the water which is pumped into Lake Erie) were monitored for insecticide residues during 1970. Big Creek, located in Norfolk County, Ontario, drains an area of 280 square miles, chiefly tobacco farms. P,p'-DDE, o,p'-DDT, p,p'-DDD. p,p'-DDT, and dieldrin were determined in water, bottom mud, and fish. The greatest concentration of total DDT was 67 parts per 10^{12} (American trillion) in the water, 441 pp 10^{9} (American billion) in the mud, and 1.0 ppm in the fish. There appeared to be a correlation between rainfall and the concentration of insecticide in the creek water. In 1970, the total amount of organochlorine insecticides that passed from this creek into Lake Erie per week averaged 0.11 lb. The drainage system, near Erieau, Ontario, drained about 1,500 acres of muck land used for growing vegetables. Concentrations of insecticides in the drainage system were greater than those in Big Creek, but the transfer of insecticides into Lake Erie was much less from the drainage system.

Miller, A. N. - See: A. S. Menon, et al, No. 229, 230.

Moore, J. E. - See: Walter A. Glooschenko, et al, No. 134.

Mudrochova, Allena - See: A. L. W. Kemp, et al, No. 189.

Mundinger, Paul C. - See: Charles F. Powers, et al, No. 271.

235. Munter, Casimir J. 1960. Chemical observations on pollution. In: Charles J. Fish (ed.), Limnological Survey of Eastern and Central Lake Erie, 1928-1929. U. S. Fish and Wildlife Service. Spec. Sci. Rept. Fish. 334. pp. 111-122.

Physical and chemical data (temperature, turbidity, pH, oxygen, alkalinity, carbon dioxide, chloride) from harbor areas and selected inshore stations gave no reason to believe that pollution caused decline of commercial fish stocks. Polluted areas were highly restricted. Fishes living in rivers and harbors may have been harmed and some spawning grounds could have been damaged.

Nair, John H. III - See: Gunter Zweig, No. 382.

236. Neil, John H. and Glenn E. Owen. 1964. Distribution, environmental requirement, and significance of Cladophora in the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 7th Conf. on Great Lakes Res. Pub 11:113-121.

The growth of Cladophora in relation to the availability of chemical nutrients is discussed. The area around Crystal Beach is specifically mentioned.

237. New York State Department of Environmental Conservation. Undated. Environmental plan for New York State. N. Y. Dept. Env. Cons. Albany, N. Y. 91 p.

Lake Erie water usage is mentioned on page 42. NSQCD.

238. New York State Department of Environmental Conservation. 1966. Periodic report of the Water Quality Surveillance Network - 1965 thru 1967 water years. N. Y. S. Dept. Env. Cons. Albany, N.Y. 390 p.

This publication is the second periodic report in accordance with Section 1210 of the Public Law. The report contains maps of the surveillance network, a presentation of the data from sampling stations, a statement of the Water Quality Standards, and a description of parameters and laboratory methods.

239. New York State Department of Health. 1954. Classification and standards of quality and purity assigned to fresh water surface waters within Lake Erie (East End) - Niagara River drainage basins in Erie, Niagara, Genessee, Orleans, and Wyoming Counties, New York. N. Y. Dept. Health. Water Pollution Control Bd. Albany, N. Y. 32 p.

Quality standards for Class A special waters (International Boundary Waters) are given.

240. New York State Department of Health. 1957. Cattaraugus Creek drainage basin. N. Y. Dept. Health. Albany, N. Y. Lake Erie-Niagara River Drainage Basin Ser. Rept. 4. 85 p.

Cattaraugus Creek and its tributaries drain an area of 565 square miles. As samples were collected, measurements of temperature, pH, carbon dioxide, dissolved oxygen (D.O.), color, odor, turbidity, and suspended matter were recorded. A mobile laboratory unit operating in the watershed area performed quantitative determinations of color, odor, turbidity, suspended matter, chlorides, alkalinity, hardness, coliform density - most probable number (M.P.N.) per 100 ml., and B.O.D.

241. New York State Department of Health. 1957. Cattaraugus Creek Basin including other drainage basins tributary to Lake Erie between Eighteenmile Creek and Big Sister Creek and between Big Sister Creek and Silver Creek. N. Y. Dept. Health. Water Pollution Control Bd. Albany, N. Y. 85 p.

Chemical parameters (i.e. D.O., B.O.D., pH, carbon dioxide, alkalinity and turbidity) were monitored in order to assess the extent of stream defilement.

242. New York State Department of Health. 1963. Lake Erie (West End) and tributary drainage basins in Chautauqua County except Cattaraugus Creek and Silver Creek drainage basins. N. Y. Dept. Health. Albany, N. Y. Lake Erie-Niagara River Drainage Basin Ser. Rept. 6. 115 p.

Temperature, pH, carbon dioxide and dissolved oxygen concentrations were measured at the time of collection of stream samples. A trailer lab or municipal lab performed measurements for odor, turbidity, suspended matter, chlorides, alkalinity, hardness and the most probable number of coliform bacteria.

243. New York State Department of Health. 1965. Cattaraugus Creek drainage basin including other drainage basins tributary to Lake Erie between Eighteenmile Creek and Big Sister Creek drainage basins and between Big Sister Creek and

Cattaraugus Creek drainage basins. N. Y. Dept. Health. Official Classifications. Albany, N. Y. 47 p.

The appendix contains the New York State classes and quality standards applicable to designated waters.

244. New York State Department of Health. 1965. Lake Erie (West End) and tributary drainage basins in Chautauqua County, except Cattaraugus Creek and Silver Creek drainage basins. N. Y. Dept. Health. Official Classifications. Albany, N.Y. 36 p.

Classifications and standards of quality and purity for surface waters within the Lake Erie drainage basin and other drainage basins in Chautauqua County except Cattaraugus Creek and Silver Creek drainage basins are given.

245. New York State Department of Health. 1965. Periodic reports of the water quality surveillance network, 1960 thru 1964. N. Y. Dept. Health. Albany, N.Y. 345 p.

Maps of the surveillance network and data from the water samples are presented.

Nicholson, H. F. - See: Walter A. Glooschenko, et al, No. 134.

246. Nriagu, J. O. 1973. Sulphur isotope abundances in Great Lakes waters: A preliminary report. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. on Great Lakes Res. pp. 1038-1043.

Lake Erie shows both regional and temporal variations in δS^{34} values. The author believes that the difference in sulfur isotopic composition between the Western and the Central or Eastern Basins depicts the constraint imposed on the natural sulfur cycle by anthropogenic activities in the adjacent cities and towns. On the other hand, the enrichment of the hypolimnion waters of the Central Basin in S^{34} relative to the epilimnion waters is to be expected. It is known that bacterial reduction of sulfates in lakes that develop bottom anoxia (and this is true of the Central Basin) results in an enrichment of the residual sulfate in the lake water with the heavier S^{34}.

247. Oeming, Loring F. 1963. Water resources management - the scientists' contribution. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:288-291.

From the standpoint of water availability, industrial growth involving heavy water-using and waste-producing processes is certain to concentrate along the Great Lakes and their connecting rivers. The newest locations for electric power generating plants are on Saginaw Bay, the St. Clair and Detroit Rivers, Lakes Michigan and Erie. A single power plant may take in and discharge over a billion gallons of water a day, with a few degrees of temperature added. Gradual warming of Great Lakes waters has been cited as a major factor in the depletion of the fishery in Lake Erie.

Studies being made on the behavior of lake currents need to be expanded so that sound decisions can be reached on how to dispose of wastes without damaging other uses of the water.

It is unrealistic to expect that agricultural interests can be deprived of the use of herbicides and pesticides or chemical fertilizers which are creating concern among water resource interests. The opportunity is unlimited for research on ways of modifying these substances and their application practices to protect the water resource while meeting the needs of agriculture.

248. Ohio Department of Natural Resources. 1953. Lake Erie Pollution Survey. Final Report. Ohio Dept. Nat. Resources. Columbus, Ohio. 201 p.

This publication contains a detailed report of the water quality of the Ohio rivers which empty into Lake Erie. Summary tables of chemical and physical quality examinations are presented, together with a discussion of individual streams. The detailed chemical analyses, daily specific conductance, water temperature and suspended sediment data are given.

249. Ohio Department of Natural Resources. 1953. Lake Erie Pollution Survey. Supplement. Ohio Dept. Nat. Resources. Div. Water. Columbus, Ohio. 125 p.

The report is composed of tables categorizing the results of chemical analyses from samples obtained at water intake stations.

250. Ohio Department of Natural Resources. 1974. List of publications. Ohio Dept. Nat. Resources. Div. Geol. Surv. Columbus, Ohio. 39 p.

A pamphlet containing the publications and maps pertinent to water resources of the State of Ohio.

251. Ohio Environmental Protection Agency. 1973. Distribution of phytoplankton and coliform bacteria in Lake Erie. Ohio Env. Protection Agency. Div. Surveillance. Twinsburg, Ohio. 69 p.

Several chemical parameters were mentioned in the discussion of this article.

252. Ohio Environmental Protection Agency. 1973. Radiological monitoring report, surface and ground waters of Ohio, 1969, 1970, 1971, 1972. Ohio Env. Protection Agency. Div. Surveillance. Twinsburg, Ohio. 19 p.

A radiological monitoring program measured radioactivity levels in surface and ground waters of the State in order to determine natural background levels and levels due to discharges from major nuclear facilities. This report summarizes data from 1969-1972 for 25 stations located throughout the state. Results from stations evaluated in this report are grouped into categories according to their location with respect to major nuclear facilities. The present Ohio Environmental Protection Agency's water quality standards specify that gross beta activity shall not exceed 100 pCi/l nor shall activity from Strontium 90 exceed 10 pCi/l, nor shall activity from alpha emitters exceed 3 pCi/l.

253. Ohio Environmental Protection Agency. 1973. Regulation EP-1 water quality standards. Ohio Env. Protection Agency. Twinsburg, Ohio. 32 p.

This document contains the revised Water Qulaity Standards of the State of Ohio, effective July 27, 1973. The standards are based upon scientific and technical knowledge accumulated by the Ohio Environmental Protection Agency and the United States Environmental Protection Agency as to the quality of waters of the State of Ohio required to sustain the following beneficial uses: municipal, agricultural and industrial water supplies, well balanced aquatic life habitat, and recreational activities.

254. Ohio Water Pollution Control Board. 1971. Annual Report for 1970. Ohio Dept. Health. Water Pollution Control Bd. Columbus, Ohio. 1 p.

The Ohio Water Pollution Control Board has adopted a procedure which maintains a constant review and steady pressure for pollution abatement and improvement of control systems. This is based on the issuance of permit-orders to municipalities, industries and other entities for waste discharges. Steady progress toward pollution abatement or satisfactory operation of approved waste treatment facilities merits renewal of these permits. Lack of progress or poor operation of facilities results in formal Board hearings and possible court action. NSQCD.

255. Ontario Water Resources Commission. 1965. Water quality data 1964-65. Ont. Water Resources Comm. Water Quality Surv. Branch. Toronto, Ont. 1:287 p.

This publication contains information about the Canadian tributaries to Lake Erie. The chemical analyses performed on stream samples include determinations for biochemical oxygen demand, solids (total, suspended, and dissolved), turbidity, phosphorus (total and soluble), nitrogen (free ammonia, total Kjeldahl, nitrite, and nitrate), chlorides, hardness, alkalinity, pH, iron, phenol, dissolved oxygen, alkyl benzene sulfonate, and conductivity.

256. Ontario Water Resources Commission. 1966. Water quality data for Ontario lakes and streams 1965-66. Ont. Water Resources Comm. Water Quality Surv. Branch. Toronto, Ont. 2:364 p.

The water quality monitoring program was commenced in July 1964 with 89 streams being sampled. By the end of the 1965-66 water year (September 30th, 1966), the program had been expanded to include a total of 124 rivers at 326 sampling stations.

Analysis of samples included some or all of the following parameters: total coliforms, alkalinity, anionic detergent, arsenic (total), biochemical oxygen demand, chemical oxygen demand, chlorides, chromium (total), conductivity, copper (total), cyanide, dissolved oxygen, ether solubles, fluoride (total), hardness, iron (total), lead (total), nickel (total), nitrogen (free ammonia, total kjeldahl, nitrite, nitrate),

pH, phenols, phosphorus (total and soluble), solids (total and suspended), sulphate, turbidity and zinc (total).

257. Ontario Water Resources Commission. 1967. Water quality data for Ontario lakes and streams 1966-67. Ont. Water Resources Comm. Water Quality Surv. Branch. Toronto, Ont. 3:373 p.

The data presented in this publication were collected as part of a routine sampling program designed to provide a continuous record of water quality information at specific points on rivers and inland lakes in Ontario. Analysis of samples included some or all of the following parameters: total coliform organisms, alkalinity, anionic detergent, total arsenic, biochemical oxygen demand, chemical oxygen demand, chlorides, total chromium, conductivity, total copper, cyanide, dissolved oxygen, ether solubles, total fluoride, hardness, total iron, total lead, total nickel, nitrogen (free ammonia, total kjeldahl, nitrite, nitrate), pH, phenols, phosphorus (total and soluble), solids (total and suspended), sulphate, turbidity, and total zinc. Anyone desiring the results of analyses for any of the foregoing parameters not included in this publication should contact the Commission.

258. Orr, Lowell P. 1969. The fishes of the upper Cuyahoga River. In: G. Dennis Cooke (Ed.), The Cuyahoga River Watershed. Kent State Univ. Inst. Limnology and Dept. Biol. Sci. Kent State Univ. Symposium, Nov. 1, 1968. pp. 57-86.

To determine if chemical concentration variations could affect the fish species present or are simply diurnal fluctuations, measurements of O_2, CO_2, pH and HCO_3 were taken at a representative station from 6:40 A.M. to 3:00 P.M. at 2-hour intervals. Three different sites at this station were sampled; site 1 was located in the center of the stream, and sites 2 and 3 were located on either side within 2 m of the shore.

Owen, Glenn E. - See: John H. Neil, No. 236.

Ownbey, C. R. - See: H. W. Poston, No. 268.

259. Ownbey, C. R. and D. A. Kee. 1967. Chloride in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 10th Conf. on Great Lakes Res. pp. 382-389.

The concentration of chloride in Lake Erie has increased threefold in the last 50 years, rising from 7 ppm in 1910 to about 23 ppm in 1964. In the light of other evidence of deterioration in Lake Erie water quality, this increase in chlorides has elicited expressions of concern for the future. This paper examines the causes of the chloride increase, the speed of the lake's response to changes in inputs, and the future outlook. Projections of future growth in population and industrial activity were utilized in arriving at estimates of future levels of chloride inputs to the lake.

Pakkala, Irene S. - See: Raymond J. Lovett, et al, No. 214.

260. Pakkala, Irene S., Merrie N. White, George E. Burdick, Earl J. Harris and Donald J. Lisk. 1972. A survey of the lead content of fish for 49 New York State waters. Pesticides Monitoring J. 5(4):348-355.

An analytical survey was made of the total lead content of 419 fish of various species sampled in 1969 from 49 New York State waters and a group of lake trout sampled in 1970 from Cayuga Lake only. Most often, lead concentrations ranged from 0.3 to 1.5 ppm, but a few samples contained levels up to 3 ppm. Fish from certain waters including Lakes Canadice, Canadaigua, Erie, Hemlock, Pleasant, and Raquette and the Hudson River showed higher lead levels more consistently than fish from other waters. No correlation was noted between lead concentration and the size, species, or sex of fish, and lead did not appear to be cumulative in the lake trout of known age up to 12 years from Cayuga Lake.

261. Pakkala, Irene S., Merrie N. White, Donald J. Lisk, George E. Burdick and Earl J. Harris. 1972. Arsenic content of fish from New York State waters. New York Fish and Game J. 19(1):12-31.

A survey of 471 fish sampled in 1969 from 49 New York State waters for total arsenic content is presented. Between 1962 and 1967 arsenic levels up to 336 ppb have been reported in Lake Erie. In general, however, fish from Lake Erie, which is considered very polluted with many chemicals, were low in arsenic.

262. Palmer, M. D. 1970. Some operational notes on a submersible, self-contained water quality meter.

Internat. Assoc. Great Lakes Res. Proc. 13th Conf. on Great Lakes Res. pp. 1015-1019.

The operation of two prototype water quality meters on the Great Lakes in depths of 7 m for four months is described. The stability and reliability of the meters was checked by laboratory calibrations and data reduction. With the exception of the turbidity sensor, the meters maintained a reasonable calibration. A vigilant field maintenance and inspection program coupled with a well-designed data system is required if valid water quality data is to be obtained.

263. Parsons, John W. 1970. Walleye fishery of Lake Erie in 1943-62 with emphasis on contribution of the 1942-61 year-classes. J. Fish. Res. Bd. Canada. 27:1475-1489.

Oxygen as it related to the survival of organisms which fish utilize as food is discussed. NSQCD.

Pearce, P. A. - See: N. Fimreite, No. 125.

Pfister, Robert M. - See: David L. Howard, et al, No. 67, 68.

Pfister, Robert M. - See: Walter O. Leshniowsky, et al, No. 210.

264. Pfister, Robert M., J. I. Frea, P. R. Dugan, C. I. Randles, K. Zaebst, J. Duchene, T. McNair and R. Kennedy. 1970. Chlorinated hydrocarbon, microparticulate effects on microorganisms isolated from Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. on Great Lakes Res. pp. 82-91.

Water samples from the Western Basin of Lake Erie have been analyzed with regard to the distribution of colloidal microparticles. Size analyses of particulate samples placed on a sucrose density gradient revealed that the most common size particle was in the range of 0.1μm. Chlorinated hydrocarbon pesticides such as endrin, aldrin, heptachlor and lindane were found in association with these particles and the data suggest that aldrin and heptachlor were found more frequently on the smaller, less dense particles, while lindane was associated with the larger, more dense fractions. Bacteria isolated from these water samples prior to chemical

analyses were grown in the presence of clay microparticles freed of pesticides, microparticles containing known amounts of pesticides, and purified pesticides alone. Bacterial growth effects were measured by changes in the turbidity of the medium, total DNA content of the culture and standard plate counts. Results demonstrate that different bacteria in the presence of endrin or aldrin could be affected in different ways. In some cases the organisms were stimulated to produce a cell yield of four to five times that of the control cultures. A survey of 151 heterotrophic aerobic bacteria isolated from Lake Erie has shown that 55 were stimulated by aldrin, 54 by endrin and 45 by dieldrin. Forty-six cultures were inhibited by aldrin, 43 by endrin and 43 by dieldrin. Eighteen cultures were stimulated by the three compounds, while 27 cultures were inhibited.

265. Pillay, K. K. S., C. C. Thomas, J. A. Sondei and C. M. Hyche. 1972. Mercury pollution of Lake Erie ecosphere. Environmental Res. 5:172-181.

The distribution of mercury in the ecosphere of Lake Erie was monitored using a highly sensitive and reliable neutron activation analysis procedure. A variety of samples from the fauna and flora of the lake as well as those from its immediate environment were analyzed for their mercury content. The results of this survey indicate a widespread distribution of mercury in air particulates, coal samples of the region, sediments, plankton/algae and fish samples from the lake, and in the brain tissues of long-time residents of the Lake Erie Basin.

266. Poppen, A. Robert. 1953. The presence of toxic materials at the mouths of Ohio streams discharging into Lake Erie, as indicated by the test organism, Dapnnia magna. In: Lake Erie Pollution Survey. Final Rept. Ohio Dept. Nat. Resources. Div. Water. pp. 137-152.

A special study was made of the industrial wastes being discharged into the Grand River. The toxicity of the industrial effluents at their point of entry into the river and the dilution necessary to render them non-toxic was determined. These wastes were sufficiently dilute before reaching Lake Erie to make them non-toxic to Daphnia magna. But the destruction of the stream bottom as a habitat suitable for aquatic life, and the barrier which a toxic zone presents to migration of aquatic animals results in a serious loss to the life of the lake as well as to the sportsmen and nature-lovers who enjoy the recreational facilities of a healthy stream.

267. Poston, H. W. 1960. The U. S. Public Health Service and the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 3rd Conf. on Great Lakes Res. Pub. 4:135-141.

A basic data program is presented. These data are the fundamental elements needed for planning and developing all of the water resources essential to the nation's economy. (UB)

268. Poston, H. W. and C. R. Ownbey. 1968. The Great Lakes water resources. J. Am. Water Works Assoc. 60(1):15-20.

Like over-fertilization, which is a biologic evolution, chemical evolution has been going on ever since the Great Lakes were formed. The rate of build-up in chemical constituents is also affected by both natural and man-made causes. Because the lakes have such a large mixing volume and an outflow which continuously removes dissolved substances, the increase in chemical concentrations in the main body of waters has been relatively slow.

Potos, Chris. - See: Curtis Ross, No. 282.

269. Potos, Chris. 1968. A study of taste and odor in the municipal water supply at Cleveland, Ohio. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. on Great Lakes Res. pp. 571-584.

The western suburbs of the City of Cleveland have had problems with taste and odor in the municipal water supply for the past several years. Upon investigation it was learned that most complaints occurred when raw water temperatures were 15 to 20 degrees colder than expected surface water temperatures.

It was noted that cold water temperature resulted from southerly prevailing winds. Winds from these directions will push the surface waters to the northern shores of the lake. As a result, the hypolimnion of the thermally stratified lake will tilt and become depressed in the northern area while rising to the south much as a saucer tilts when applying pressure to one side. During southerly winds the raw water intake will be inundated in the hypolimnion. Northerly winds will eliminate the hypolimnion from the intake area.

Chemical and biological results show that when a hypolimnion is present, and low dissolved oxygen conditions prevail, greatly increased quantities of iron, manganese, dissolved solids, alkalinity, hardness, and phytoplankton appear in the hypolimnion and area of the thermocline. Under these conditions large increases in total phytoplankton are also noted in the epilimnion.

270. Potos, Chris. 1970. Hypolimnetic oxygen depletion mechanisms in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. on Great Lakes Res. pp. 707-714.

To the present, the mechanism of hypolimnetic deoxygenation of temperate lakes has been little understood. It is the consensus among limnological investigators that a slow, progressive, sediment biochemical oxygen uptake rate, exerted by microbiological flora in the decomposition of sedimented plankton and other degradable organic debris, is the mechanism responsible for depleting any hypolimnion of oxygen during stratification periods.

Success in the measurement of a positive depletion rate in the summer of 1968 in the Lake Erie Central Basin and correlation of this rate with existing sediment and hypolimnion oxygen demand, infers the probability of still another operative factor - that of chemical oxygen demand satisfaction. The total mechanism of the depletion, abetted by sediment resuspension due to wind-induced water turbulence, can be chemical and microbiological in nature, both at one and the same time.

271. Powers, Charles F., David L. Jones, Paul C. Mundinger and John C. Ayers. 1960. Applications of data collected along shore to conditions in Lake Erie. Univ. Mich. Great Lakes Res. Div. Pub. 5:78 p.

The results and techniques presented in this report have come from the Lake Erie pilot study on the usefulness of the data being accumulated by municipal and industrial users of lake water. They show that these data have a potential in understanding past events in the lake and in "watching" the lake for the development of trends in the future.

The pilot study and the studies of past aquatic conditions that have accompanied it have made available a substantial amount of new information and techniques which may help

explain the causes of past fluctuations in the commercial fisheries and contribute to our understanding of the more academic problem of eutrophication of lakes.

There are still a number of facets of the past conditions of the aquatic environment that have yet to be studied. Among these may be mentioned the assembly of a record of past unusually severe or unusually mild meteorological conditions and their probable effects on the lake, further search for biological indication of changing or changed conditions in the water, and the development of a set of criteria by which the data from representative water-user installations can be watched for the development of trends favorable or unfavorable for commercially important fish species.

272. Powers, Charles F. and Andrew Robertson. 1966. The aging Great Lakes. Sci. American. 215(5):94-104.

A study of the Detroit River by the U.S. Public Health Service showed that its waters contain large quantities of sewage bacteria, phenols, iron, oil, ammonia, chlorides, nitrogen compounds, phosphates and suspended solids. Similar waste materials are discharged into the lake by the steel, chemical, refining and manufacturing plants along the lake. Pollution is particularly serious in Lake Erie because of the lake's shallowness; its volume of water is too small to dilute the pollutants effectively.

Randles, Chester I. - See: Walter O. Leshniowsky, et al, No. 210.

Randles, Chester I. - See: R. M. Pfister, et al, No. 264.

Reavey, Thomas C. - See: Paul J. Magno, et al, No. 220.

273. Reiger, H. A. and W. L. Hartman. 1973. Lake Erie's fish community: 150 years of cultural stresses. Science. 180(4092):1248-1255.

Cultural eutrophication has caused several marked changes in Lake Erie. Among these is the great increase in total concentrations of most major ions over the past 50 years. Total dissolved solids have risen from 133 to 183 milligrams per liter, and concentrations of calcium, chloride, sodium plus potassium, and sulfate have rised by 8, 16, 5, and 11 mg/liter, respectively. The nutrient ions, nitrogen, and phosphorus, appear to have increased threefold since 1930.

274. Reinert, Robert E. 1970. Pesticide concentrations in Great Lakes fish. Pesticide Monitoring J. 3(4):233-240.

The Bureau of Commercial Fisheries has been monitoring insecticide levels in fish from the Great Lakes, including Lake Erie. The two insecticides found in all Great Lakes fish have been DDT (DDT, DDD, DDE) and dieldrin. Fish from Lake Michigan contain from 2 to 7 times as much of these insecticides as those from the other Great Lakes. Insecticide levels calculated on a whole-fish basis show a marked difference from species to species. Within a species there is also an increase in DDT and dieldrin levels with an increase in size. If these insecticide levels are, however, calculated as ppm of insecticide in the extractable fish oil, the differences in concentration between species and the differences between size groups becomes considerably less. Laboratory experiments indicate that fish can build up concentrations of DDT and dieldrin at the parts-per-million level from parts-per-trillion concentrations in the water.

275. Reitze, Arnold W. 1968. Wastes, water, and wishful thinking: The battle of Lake Erie. Case Western Law Review. 20(1):5-86.

Pollution in the form of sewage, chemical fertilizers, industrial wastes, pesticides and herbicides, silt, thermal, and oil spills is considered for the effect on "useful or useable" water. The legal actions of private and public sectors are discussed in terms of overlapping activity, goals and mode of action. Within the discussion, details of the sphere of influence of all governmental agencies are considered. The concluding section of the article contains recommendations for pollution abatement.

276. Rhodes, Russell G. and Anthony J. Terzis. 1970. Some algae of the upper Cuyahoga River. Ohio J. Sci. 70(5):295-299.

The ionic content of water as it relates to algae growth is discussed.

277. Risley, Clifford Jr. and William L. Abbott. 1966. Radioactivity in Lake Erie and its tributaries. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:416-422.

Gross alpha and gross beta radioactivity levels of water, bottom sediment, and plankton samples in Lake Erie and in the tributary mouths were determined in a study conducted by the U.S. Public Health Service from 1963 to 1965. Values for dissolved solids and bottom sediment beta activities in the lake were generally quite low with ranges of less than one to 39 picocuries per liter and 11 to 81 picocuries per gram, respectively. Plankton beta activity results ranged from 33 to 1200 picocuries per gram, indicating the ability of these organisms to concentrate radionuclides. The tributary alpha and beta radioactivity values were low with slightly higher activities evident during the spring season, which may only be reflecting increased precipitation and runoff. Lake Michigan average radioactivity results, by comparison, differed little from Lake Erie values; but the individual activities exhibited greater ranges, and higher results tended to cluster around the northern part of the lake, especially in Green Bay.

278. Ritchie, Gary A. and James N. Speakman. 1973. Effects of settling time on quality of supernatant from upland dredge disposal facilities. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. on Great Lakes Res. pp. 321-328.

Investigations into the quantity of sediments dredged from Ashtabula and Fairport Harbors, Ohio and the effect of settling on quality of the supernatant were conducted for the Buffalo District, Corps of Engineers.

Settling times of 1 - 40 hr produced 95-99% reductions in the concentrations of most pollutants tested. Total phosphorus and Kjeldahl nitrogen were reduced from 10 and 700 mg/l, respectively, to less than 1 and 75 mg/l after one hour. Heavy metals present in concentrations up to 260 mg/l, were reduced to below 0.3 mg/l after one hour and 0.1 mg/l after 40 hr.

Calculations indicate that use of confined disposal facilities at Ashtabula and Fairport Harbors would reduce pollutant loading to Lake Erie from dredging by more than 95% for most contaminants.

Robeck, Gordon G. - See: Kenneth A. Dostal, No. 115.

Robertson, Andrew - See: Charles R. Powers, No. 272.

Rodgers, G. K. - See: D. V. Anderson, No. 9.

Rodgers, G. K. - See: James R. Kramer, No. 200.

279. Rodgers, G. K. 1963. Lake Erie data report, 1960. Univ. Toronto. Great Lakes Inst. Toronto, Ont. Prelim. Rept. 11. 138 p.

This report details the data taken on surveys of a research vessel during synoptic cruises for the year 1960. Included in the report are data on weather, radiation, limnological, phenol and bacterial contamination, and bathythermograph observations.

280. Rodgers, G. K. 1972. Great Lakes Institute data calalogue and methods for 1960 to 1970. Univ. Toronto. Inst. Env. Sci. and Eng. Pub. EG-7. 301 p.

Data from the chemical surveys of Lake Erie are recorded in tables. Each sampling cruise is listed separately.

Rohlich, Gerard A. - See: Gus E. Fruh, et al, No. 131.

281. Roosen, J. James and Robert C. Ball. 1971. Ecological effects of a thermal power plant on the aquatic habitat of a large fresh water lake in the United States. Eighth World Energy Conf., June 28 - July 2. Bucharest, Rumania. 19 p.

The Detroit Edison Company, located in southeastern Michigan uses these waters for a variety of purposes, the largest of which is the economical condensation of steam to provide a low-cost and reliable source of electric power for the area. Recent expansion of electrical use in the area has resulted in the siting of a 3200-megawatt fossil-fueled plant on the Michigan shore of the Western Basin of Lake Erie, the geologically oldest of the five lakes. This paper describes the qualifying and quantifying of the chemistry and biology of the aquatic environment of the lake receiving discharges from the large generating plant. Included are the design basis and description of the ecological program that was formulated by Michigan State University to determine the impact of the plant on the aquatic habitat. The paper details information to be collected in the areas of: (1) basic plant producing groups - the periphyton, the phytoplankton and the macrophytes, (2) zooplankton, (3) bottom fauna, (4) fish, and (5) waterfowl. Physical and chemical studies are also described.

Ross, Curtis - See: N. M. Burns, No. 60, 61, 62, 63, 64, 65.

282. Ross, Curtis and Chris Potos. 1968. The quantitative determination of ferrous iron in lake sediments. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. on Great Lakes Res. pp. 585-587.

The test for ferrous iron employs an oxidation-reduction procedure in which potassium dichromate is used as the standard oxidizing solution and diphenylamine sulfonate as the indicator. Caution must be exercised in all instances to exclude an oxidizing atmosphere above the test specimen. Phosphoric acid is added early in the procedure to complex any initial ferric iron in the specimen and also to complex the ferric iron formed upon oxidation by titration with dichromate. Excellent recoveries with a high precision have been obtained.

Roth, James C. - See: Clare L. Schelske, No. 286.

283. Rouse, Frederick O. 1972. The 1972 Water Quality Agreement: Canadian-U.S. efforts to clean up the Great Lakes. Limnos. 5(1):2-7.

The Water Quality Agreement provides for the establishment in the Great Lakes of a permanent Water Quality Board to monitor the progress of the several governments in achieving the objectives established in the Executive Agreement. This article describes the specific chemicals and their concentration in the lake water.

Saitoh, H. - See: Y. K. Chau, No. 92.

284. Saunders, George W. 1963. The biological characteristics of freshwater. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. on Great Lakes Res. Pub. 10:245-257.

Inorganic nutrients are important in determining the kinds, amounts, and activities of organisms. Superimposed on a simple primary system, there is a second order of events. Organisms not only feed, but there is a multiplicity of factors which may control or limit their feeding. These are the environmental factors operating in the ecosystem, such as light, temperature, nutrients, ectocrine substances, age structure and selectivity of a population, etc. No single environmental factor is ever controlling or limiting

to the ecosystem. Probably no single environmental factor is normally controlling or limiting to even a single population in an ecosystem for any length of time. NSQCD (UB)

285. Saunders, George W. 1964. Studies of primary productivity in the Great Lakes. Univ. Mich. Great Lakes Res. Div. Proc. 5th Conf. on Great Lakes Res. Pub. 11:122-129.

The programs presented herein attempted to gain some insight as to the distribution of photosynthesis in western Lake Erie. Another program attempted to develop and evaluate a shipboard method for estimating photosynthesis. Some additional inference concerning photosynthesis can be made using known concentrations of chlorophyll in Lakes Superior, Michigan, Erie, and Ontario. No data are available for Lake Huron.

286. Schelske, Claire L. and James C. Roth. 1973. Limnological survey of Lakes Michigan, Superior, Huron, and Erie. Univ. Mich. Great Lakes Res. Div. Pub. 17:108 p.

The study gathered extensive physical, chemical and biological information with uniform methods from four of the lakes within a 4-week period. Chemical data include temperature, transparency, dissolved gases, pH, alkalinity, major ions, nutrients, chlorophyll and carbon fixation by phytoplankton.

287. Schelske, Claire L. and Eugene F. Stoermer. 1972. Phosphorus, silica, and eutrophication of Lake Michigan. In: Nutrients and Eutrophication. Univ. Mich. Ann Arbor, Mich. Special Symposia. 1:157-171.

Lake Michigan and Lake Erie are compared in terms of silica and nitrogen.

Schibi, Michael J. - See: Richard L. Carr, et al, No. 85.

288. Schindler, D. W. 1974. Eutrophication and recovery in experimental lakes: Implications for lake management. Science. 184(4139):897-899.

It appears that a basin-wide ban on detergent phosphates would quickly bring about a partial recovery of Lakes Erie and Ontario, perhaps as much as a decade before full-scale phosphorus control by other means is possible. Such a recovery would provide a savings of many millions of dollars, as well as restoring to some degree the beauty of these enormous resources.

Schmidt, Ronald L. - See: Raymond E. Wildung, No. 371.

289. Schneider, R. Stephen (Ed). New pollution buoy set in Lake Erie. Limnos. 2(1):25.

The pollution monitoring system, which is housed in a moored buoy five miles offshore in Lake Erie at a point almost directly north of downtown Cleveland, is presently equipped to sense and transmit water temperature, oxygen levels in the water, pH values, and mechanical stress data concerned with the forces and motions of the moored buoy system itself. The system is designed to measure the acidity of the water, temperature variation and gradient, wave height and frequency, wind speed, wind direction, turbidity, and conductivity.

290. Schrag, Peter. 1969. Life on a dying lake. Saturday Rev. 20(Sept.):19-21, 55-56.

The federal government has identified 360 sources of industrial waste - power plants, steel mills, chemical companies, food processors, rubber companies, etc. But the greatest polluters may be the city sewage systems themselves. The federal government has estimated that with existing treatment facilities, the cities along the lake discharge effluent equal, in its composition and effects on the lake, to the raw sewage from a population of 4,700,000 people. Some cities are providing secondary treatment, some primary, some none at all. NSQCD.

291. Schwab, G. O., G. S. Taylor and A. C. Waldron. 1970. Measure pollutants in agricultural drainage. Ohio Rept. (July-Aug.) pp. 87-89.

The pollution of Lake Erie has caused a decrease in desirable commercial fish and deterioration of water quality which affects recreational, municipal, and industrial uses of the water. Pollution of these waters occurs from industrial, municipal, and agricultural sources. The Federal Water Pollution Control Administration reported that 83 percent of the phosphorus entering Lake Erie originates from municipalities and industries. The remaining 17 percent enters from rural runoff, although it is not known how much of this phosphorus originates separately from septic tanks, cultivated fields, animal feedlots, canneries, etc. The actual contribution of pesticide residues attributed to agricultural runoff is not known, but it could be significant. Studies are therefore underway to determine levels of pollutants in runoff water from agricultural lands.

292. Sedlander, Norman R. 1966. Effect of low pressure aeration of stagnant estuaries. Univ. Mich. Great Lakes Res. Div. Proc. 9th Conf. on Great Lakes Res. Pub. 15:430-438.

Studies of low pressure aeration in a relatively stagnant estuary were carried out during the summers of 1963, 1964, and 1965. The approach in 1963 was preliminary; in 1964 the lagoon (yacht marina) was left unaerated but in 1965 DeVilbiss compressor units (powered with 1/2 horse power motors) produced a continuous bubble diffusion with the result that algae remained in suspension and the nutrients in the water were increasingly reduced. Laboratory studies conducted at the same time confirmed the observation that aeration caused increased growth rates of algae and increased nutrient reduction.

The microbiological studies disclosed a higher phytoplankton population in the lagoon as compared to that of the adjacent Maumee River. Coliform and enterococci densities were, on the average, lower than the densities in the river. In general the biological oxygen demand was higher in the lagoon than in the river for the demand levels followed the available dissolved oxygen. The conclusions possible from these experiments were that aeration could very likely reduce pollution in stagnant bodies of water and prove efficacious in the tertiary treatment of sewage effluent as well as the secondary treatment for small communities where lagoon acreage was available.

293. Seltzer, Louis B. 1965. Cleveland: saving Lake Erie. Saturday Rev. 48(Oct.):36, 41.

This article discusses the program to save Lake Erie. The HEW conferences on pollution are reported. NSQCD

Shema, Robert L. - See: Daniel G. Bardari, et al, No. 21.

Sheperd, William F. - See: Harry D. Van Meter, No. 349.

294. Sibley, Thomas H. and K. M. Stewart. 1969. Some variations in the quality of water from the source and mouth of the Niagara River. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. on Great Lakes Res. pp. 774-785.

An investigation in 1967 and early 1968 compared similarities and differences in selected variables of water quality from

the source and mouth of the Niagara River. The source of the River is the large volume discharge from Lake Erie. Comparisons were made of temperature, dissolved oxygen, pH, hardness, alkalinity, calcium, magnesium, sodium, potassium, chlorides, total residue, fixed solids and conductivity. Chlorides and conductivity were continuously higher at the mouth. The mean values of all parameters, except total residue and fixed solids, were slightly higher at the mouth. Although the increases were relatively slight, the discharge from Lake Erie is so great that even slight changes in water quality between the source and mouth represent impressive inputs into the river.

Sikes, Charles S. - See: Lester J. Walters Jr., et al, No. 361.

295. Simpson, George D., Lamont W. Curtis and Henry K. Merkle. 1969. The Cuyahoga River: Lake Rockwell to Lake Erie. In: G. Dennis Cooke (Ed.), The Cuyahoga River Watershed. Kent State Univ. Symposium, Nov. 1, 1968. Kent State Univ. Inst. Limnology and Dept. Biol. Sci. pp. 87-120.

Using collected laboratory data, profiles were prepared of the important chemical characteristics of the river including dissolved oxygen, temperature, BOD, COD, suspended, total, and dissolved solids, ammonia, nitrite, and nitrate nitrogen, phosphorus, chlorides, total sulfate, fecal coliform organisms, and fecal streptococci. Monthly variations of these parameters were plotted. Typical profiles are shown in the plots of sulfate, chloride, and fecal coliform concentrations. These profiles indicate the locations of major input points and variations in these parameters, as well as the portion of the river in which concentrations of various parameters may approach or exceed the requirements of various water quality criteria.

Skoch, Edwin J. - See: N. Wilson Britt, et al, No. 52.

Skoch, Edwin J. - See: Lester J. Walters Jr., et al, No. 361.

296. Skoch, Edwin J. 1970. Keynote Address. In: Paul Kantz, Jr. (Ed.), Environmental Problems of the Lake Erie Basin. John Carroll Univ. Lake Erie Conf. Carroll Business Bull. Spec. Issue. 10(1):5-6.

The general pollution and eutrophication of Lake Erie is discussed. NSQCD

297\. Skoch, Edwin J. 1971. Changes in the sediment chemistry of Lakes Erie and Ontario. In: Robert A. Sweeney (Ed.), Proceedings of the Conference on Changes in the Chemistry of Lakes Erie and Ontario. Bull. Buffalo Soc. Nat. Sci. 25(2):67-76.

The following points were summarized in this article:
(1) Lakes Erie and Ontario are quite similar in their sediment characteristics.
(2) Differences in the chemical composition of the sediment are possibly due to depth differences and material inflow.
(3) Despite the fact that the sediment plays an important role in the cycling of materials in the lake system, very little data are available on this topic.
(4) No data were discovered which would show changes in sediment chemistry over the years.
(5) The data now available were randomly gathered and often not comparable in the differences in analytical procedures and the time and techniques of sampling.

298\. Skoch, Edwin J. and Wilson N. Britt. 1969. Monthly variation in phosphate and related chemicals found in the sediments in the Island area of Lake Erie, 1967-68, with reference to samples collected in 1964, 1965, and 1966. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. on Great Lakes Res. pp. 325-340.

Samples of sediment collected in 1964, 1965, 1966, and on a monthly basis from May 1967 through November 1968 were analyzed for total phosphate, iron and organic carbon. Samples were collected by means of an Ekman Dredge and by means of a core technique developed by Dr. Skoch. The cores were sectioned at 2.5 cm intervals and each of the six sections were analyzed for the same factors.

Results of the analyses showed only a slight increase in phosphate since 1964. However all three factors showed a definite increase from May 1967 through November 1968. Monthly variation was quite distinct and more severe than the differences between years. The two sampling methods yielded slightly different results. The sediment was found to consist of two distinct layers, with the upper 5 cm of sediment being usually higher in concentrations of materials than the lower portions.

299. Skoch, Edwin J. and Joann M. Turk. 1972. Fluctuations in the level of mercury in sediments collected from the Island area of Lake Erie, 1964-1968. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. on Great Lakes Res. pp. 291-297.

Samples of sediment collected in 1964, 1965, 1966 and on a monthly basis from May 1967 through November 1968 were analyzed for total mercury content. Samples were collected by means of an Ekman grab and a core technique.

Results of the analyses show only a slight increase in total mercury since 1964. However there was a greater increase from May 1967 through November 1968. Monthly variation was quite distinct and larger than the differences between years. The core samples do not indicate a definitive layering of mercury. The results from these analyses of the samples show similar patterns of fluctuation when compared to the varying levels of phosphate, iron and organic carbon in these sediments as previously reported by the first author.

Smith, D. J. - See: A. W. Breidenbach, et al, No. 47.

Smith, Kenneth R. - See: N. Wilson Britt, et al, No. 52.

300. Smith, Stanford H. 1962. Lake Erie or Lake Eerie? Izaak Walton Mag. pp. 4-5.

Inorganic industrial wastes, including toxic substances such as cyanide and phenols, have been reported in analyses of tributary streams and lake waters. In addition, the load of organic industrial waste entering Lake Erie in 1953 was estimated by the U. S. Public Health Service to equal that from a population of about 900,000. Concentrations of most dissolved chemicals have increased during the last 50 years.

301. Smith, Stanford H. 1968. That little pest the alewife. Limnos. 1(2):12-20.

Iodine and oxygen as essential chemicals for fish habitat are discussed. NSQCD

Sondei, J. A. - See: K. K. S. Pillay, et al, No. 265.

Spangler, G. R. - See: P. J. Colby, et al, No. 98.

Speakman, James N. - See: Gary A. Ritchie, No. 278.

302. Steggles, W. A. and J. Thon. 1968. Effects of waste discharges on harbour areas. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. on Great Lakes Res. pp. 588-592.

Industrial and municipal developments in harbour areas in the Lower Great Lakes have created localized water quality management problems. The Ontario Water Resources Commission has carried out detailed studies of the chemical and physical effects of waste discharges within the harbour areas and adjacent lake waters.

Results of 1966 and 1967 studies at the Wheatley harbour are presented to illustrate the waste dispersion, settling and decay patterns encountered in harbour areas. The major parameters considered are BOD, dissolved oxygen, total and soluble phosphate, total and dissolved solids, conductivity, ammonia and turbidity.

The effects of waste discharges on the water uses are discussed together with control measures required to protect the uses.

Stephenson, M. E. - See: C. S. Annett, et al, No. 10.

Stewart, Kenton M. - See: Gus E. Fruh, et al, No. 131.

Stewart, Kenton M. - See: Thomas H. Sibley, No. 294.

Stierli, H. - See: A. W. Breidenbach, et al, No. 47.

Stoermer, Eugene F. - See: Clare L. Schelske, No. 287.

303. Strachan, W. M. J. 1973. A statistical examination of Great Lakes chemical monitor data at Canada Centre for Inland Waters. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. on Great Lakes Res. pp. 949-957.

Between August 1971 and December 1972, twenty-two cruises at the Canada Centre for Inland Waters were concerned with statistical sampling from Lakes Ontario, Erie and Huron. Data for fifteen chemical parameters were examined to determine the precision of the measurements. There was little significant difference between pump and bottle sampling methods and no standard deviation pattern evidence itself as a function of depth or sample value. Hypolimnion waters were also examined briefly.

304. Stroud, R. H. (Ed.). 1970. Fishing restrictions re mercury. SFI Bull. Washington, D.C. 219:2-3.

A survey of all the state fish and game (conservation) agencies was conducted by the U. S. Bureau of Sport Fisheries and Wildlife (BSFW) to ascertain the extent and nature of state-imposed fishing restrictions because of mercury (Hg) contamination. Following are those restrictions as compiled by BSFW through September 1, 1970. A subsequent recheck, with a responsible official of the Federal Water Quality Administration revealed that the list of restrictions was accurate through September 21, 1970.
Ohio - Lake Erie walleye closed to commercial fishing.
New York - Lake Erie danger warnings.
Pennsylvania - Lake Erie danger warnings walleye, drum, small mouth bass, white bass.

305. Stroud, R. H. (Ed.). 1970. Known mercury dischargers-analysis positive (as of Sept. 4, 1970). SFI Bull. Washington, D. C. 220:6-8.

The amount of mercury discharged by NOSCO Plastics, Malinckrodt Chem. and General Electric Co. into Lake Erie are listed.

306. Stroud, R. H. (Ed.). 1970. Most angling waters mercury-safe. SFI Bull. Washington, D. C. 218:1-3.

According to a recent report on Lake Erie from the Ontario provincial government, only white bass and walleyes are contaminated at dangerous levels in the Western end of that lake or in the Detroit River.

307. Stroud, R. H. (Ed.). 1971. Mercury pollution survey. SFI Bull. Washington, D. C. 221:4-7.

New York State sport fishermen are advised not to eat catch from Lake Erie. Ohio analysis of walleyes revealed .25 ppm mercury in composit samples of three 2-pound fish and none in composit samples of three 8-oz fish. Commercial fishing for Lake Erie walleyes was prohibited on April 13, 1970 whereas the ban on sale of other commercially-caught species was lifted May 22, 1970. Sportsmen were advised not to eat fish other than perch caught in Lake Erie.

308. Sutherland, Jeffrey C. 1970. Silicate mineral stability and mineral equilibria in the Great Lakes. Env. Sci. and Tech. 4(10):826-833.

In Lakes Erie and Ontario, where water has been misused, the capacities of equilibrium systems are exceeded. Although Lake Erie is in equilibrium with reference to phosphate and carbonate minerals, summer orthophosphate values in the Western end of the lake are excessive with respect to equilibrium. Phosphate with other nutrients supports overproductivity by diatoms which depletes SiO_2(aq.) to levels below control by silicate equilibria. Hence, in Lakes Erie and Ontario, the reaction provides additional, inexhaustible supplies of natural silica to feed the process. Clearly, the rate of addition of nutrients is too rapid for a close approach to equilibrium.

309. Sweeney, Robert A. 1969. Metabolism of lindane by unicellular algae. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. on Great Lakes Res. pp. 98-102.

The loss of lindane in the absence of algae was due probably to the codistillation of the insecticide with water. The significantly higher rate of disappearance, coupled with the presence of a known lindane metabolite, is evidence that both Chlorella and Chlamydomonas can detoxify this pesticide. This may explain, in part, the relatively low concentrations of lindane in the open water of lakes, including Lakes Erie, Michigan and Ontario, when contrasted to other chlorinated hydrocarbon insecticides that have been applied in similar manner and quantity.

310. Sweeney, Robert A. 1971. Selected ecology references concerning the greater Cleveland area of Lake Erie. In: A New Appraoch to the Cleveland Northeastern Ohio Region. The Lake Erie International Jetport Project. Pre-feasibility Tech. Rept. Greater Cleveland Growth Assoc. pp. 152-156.

A pertinent bibliography for the Lake Erie region is presented.

311. Sweeney, Robert A. 1973. Impact of detergent phosphate reduction on water quality. Internat. Assoc. Great Lakes Res. Proc. 16th Conf. on Great Lakes Res. pp. 967-976.

Stream quality was measured at 164 stations on 28 major streams during June through August 1970-1972 in Erie County, New York. Twelve of these sites in remote regions served as controls. During this period, the phosphate content of

detergents sold in the county was limited to a maximum of 8.7% P as of 30 April 1971 and 0.5% P as of 1 January 1972. Parameters for the water measured included phosphates (ortho and total), chlorides, nitrates and BOD and for sediment included total phosphates, solids, oils and greases, nitrogen (ammonium, organic and nitrates) and chlorine demand. Algal biomass also was determined as was precipitation and stream discharge. Changes in the phosphorus content of domestic sewage at five plants which treated more than 90% of the municipally treated wastewater also was monitored. The ortho and total P content of the influent to and effluent from municipal sewage treatment plants decreased by 25 and 20% respectively, in 1971 and 55 and 45% in 1972. At the same time, the ortho and total phosphorus in the streams declined by 47 and 33% in 1971 and 67 and 60% in 1972. Algal biomass decreased by 27% in 1971 and 55% by 1972. BOD improved by 20% (1971) and 27% (1972). At the control locations, the above parameters, with the exception of BOD which increased by 90% in 1972, did not change significantly. There was no major difference in rainfall or discharge between the study periods. Since no improvement in sewage treatment plants and collection systems occurred in the county, it was concluded that the phosphate detergent limitation resulted in an improvement in stream quality and a limitation of eutrophication.

Taylor, G. S. - See: G. O. Schwab, et al, No. 291.

Terzis, Anthony J. - See: Russell G. Rhodes, No. 276.

Thomas, C. C. - See: K. K. S. Pillay, et al, No. 265.

Thomas, N. A. - See: A. M. Lucas, No. 215, 216.

312. Thomas R. L. 1969. A note on the relationship of grain size, clay content, quartz and organic carbon in some Lake Erie and Lake Ontario sediments. J. Sed. Petrol. 39(2):803-809.

Determination of the geochemistry of fine-grained sediments in relation to size frequency distribution was carried out on sediment samples from Lakes Erie and Ontario. This study demonstrated a direct relationship between 2 micron grain size and the theoretical clay content computed from the organic carbon, quartz and carbonate content. A sympathetic relationship was observed between clay content and organic carbon, and between median grain size and quartz content. The former relationship is believed to be the result of

absorption from solution; the latter is brought about by natural sedimentation from suspension.

313. Thommes, M. M., H. F. Lucas, Jr. and D. N. Edgington. 1972. Mercury concentrations in fish taken from offshore areas of the Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. on Great Lakes Res. pp. 192-197.

For two individual species, bloater and lake trout (where individual fish sampled were of widely differing size), no correlation could be seen between mercury content and weight. The fish were grouped according to feeding habits and both significant differences and similarities were seen between trophic levels and lakes. Generally, the concentrations of mercury in piscivores were higher than those in either bottom feeders or planktivores. In fish taken from Lake Erie, for example, the mercury content of wet flesh from piscivores averaged 0.47 ppm, while that of fish feeding on benthic or planktonic organisms averaged 0.24 and 0.14 ppm, respectively. No significant difference was seen for the same feeding groups from each lake. The bottom feeders, excluding sculpin and stickleback, from Lakes Erie, Michigan and Superior were not significantly different and averaged 0.24, 0.26 and 0.19 ppm, respectively. The sculpins and sticklebacks are interesting anomalies due to their exceptionally high mercury concentration, ranging from 0.52 to 1.13 ppm and 0.96 ppm (wet flesh), respectively. All of these samples were above the U. S. Food and Drug Administration interim guideline of 0.5 ppm. It is suggested that these offshore levels result from natural geochemical sources of mercury.

Thompson, Lawrence C. - See: Barnard S. Meyer, et al, No. 231.

314. Thompson, Mary H. and Robert N. Farragut. 1965. The amino acid composition of the alewife (_Alosa pseudoharengus_). Fish. Industrial Res. 3(1):47-53.

Large quantities of the species are available in Lakes Ontario, Erie, Huron, and Michigan, where for the past few years the Bureau of Commercial Fisheries research vessel _Kaho_ has caught it in commercial quantities. Several uses have been proposed for the fish, chief among them being for fish meal or heat-processed animal foods. Because little has been known of the chemical composition of the species, the purposes of this paper are to report its amino acid composition and to record

any seasonal variations in those acids. These variations are discussed in terms of total available nitrogen, ninhydrin-positive compounds, and protein amino acid concentration.

Thon, J. - See: W. A. Steggles, No. 302.

Traversy, W. J. - See: V. K. Chawla, No. 95.

315. Tufty, Barbara. 1966. The dying lake. Science News. 90:10-11.

This article tells about the kinds of wastes deposited into Lake Erie. The effects of pollution on fresh water are described. NSQCD

Turk, Joann M. - See: Edwin J. Skoch, No. 299.

316. U. S. Army Corps of Engineers. 1969. Dredging and water quality problems in the Great Lakes - Summary Report. Corps of Engineers. Buffalo District. Buffalo, N.Y. 1:338 p.

Within this report are the listings for federal and state water quality standards. Data from both the Federal Water Pollution Control Administration, as well as the Corps' data is presented. When determining the effect of dredging on water quality, samples were taken before and after a disposal operation.

317. U. S. Army Corps of Engineers. 1971. Cuyahoga River, Ohio: Today-tomorrow, framework, early-action, and summary restoration study. First Interim Report. Corps of Engineers. Buffalo District. Buffalo, New York. 104 p. + plates + bibliography.

Water quality and the current status of the following are discussed: recreation, fish and wildlife, aesthetics, stream supply, erosion and sedimentation, flood control, and navigation. Possible remedial measures and areas needing further study are detailed.

318. U. S. Army Corps of Engineers. 1973. Southeastern Michigan wastewater management survey scope study. Summary Report. Corps of Engineers. Detroit District. Lansing, Mich. 144 p.

The survey region encompasses Michigan streams discharging into the St. Clair River, Lake St. Clair, the Detroit River,

and Lake Erie. This report discusses a plan to meet the long range needs of the region for protection against floods, wise use of flood plain lands, improvement of navigation facilities, water supplies for industrial and municipal purposes, outdoor recreational facilities, the enhancement and control of water quality and related purposes, all with a view to encouraging and supporting the optimum long range economic development of the region. (CE)

319. U. S. Army Corps of Engineers. 1973. Summary report for Cleveland-Akron metropolitan and Three Rivers watershed areas. Wastewater Management Study. Corps of Engineers. North Central Div. Chicago, Ill. 207 p.

The basic wastewater sources considered in the study are municipal sewage, industrial waste flows, and combined and separate urban stormwater runoff. Within this report, the Corps of Engineers examined a wide range of advanced wastewater treatment technologies, formulated alternative plans to achieve a range of effluent water quality goals, and, for four selected alternative plans, illustrated how implementation would be phased in accordance with guidelines established by the Federal Water Pollution Control Act Amendments of 1972.

320. U. S. Army Corps of Engineers. 1973. Water resources development in Pennsylvania. Corps of Engineers. North Atlantic Div. New York, N.Y. 108 p.

The part of the Commonwealth of Pennsylvania in the Lake Erie basin has a shore frontage of 48.4 miles, lying between Ashtabula County, Ohio and Chautauqua County, New York. This pamphlet provides current information on the scope and progress of water resources development. It describes the Corps' role in planning and building these improvements and includes an explanation of the procedure for initiating and processing them. NSQCD

321. U. S. Bureau of Sport Fisheries and Wildlife. 1973. Progress in sport fishery research, 1971. U. S. Bureau Sport Fish. and Wildlife. Washington, D. C. Resources Pub. 121. 157 p.

The following two articles pertained to Lake Erie:
(1) Fish taken from Lake Erie were studied for the uptake and retention of methyl mercury in tissues.
(2) The specific chemical requirements for optimum diatom growth are reported.

322. U. S. Department of Health, Education, and Welfare. 1963. Water pollution surveillance system: Annual compilation of data October 1, 1962 - September 30, 1963. U. S. Dept. Health, Education, and Welfare. Public Health Service. Div. Water Supply and Poll. Control. Washington, D.C. 1:63-71 (Northeast Basin) and 4:25-26, 85-102 (Western Great Lakes and Lake Erie Basins).

The 6th annual compilation of data includes information collected by the Public Health Service Water Pollution Surveillance System (formerly the National Water Quality Network). The data includes findings on pesticides, organic chemicals and trends in radioactivity. (BECPL)

323. U. S. Department of Health, Education, and Welfare. 1965. Proceedings: Conference in the matter of pollution of Lake Erie and its tributaries, Cleveland, Aug. 3-6. U. S. Dept. Health, Education, and Welfare. Washington, D. C. Vol. 1-4. 1099 p.

Effects of wastes on water quality and subsequent water use is the point of the conference. All phases of the pollution problem were under discussion. Throughout the presentation, the sources of wastes, the type of treatment system, and efficiency thereof were detailed. Subsections of the report deal with each river which flows into Lake Erie. Recommended actions in terms of legislation and enforcement are part of the discussion.

324. U. S. Department of Health, Education, and Welfare. 1965. Proceedings: Conference in the matter of pollution of Lake Erie and its tributaries, Buffalo, Aug. 10-11. U. S. Dept. Health, Education, and Welfare. Washington, D. C. Vol. 1-2. 496 p.

This is the third in the series of conferences held under the provision of section 8 of the Federal Water Pollution Control Act. The need for defining water quality in terms of water use was discussed. Political statements about the progress New York State has made in pollution abatement are on record. Recommendations for action in terms of legislation and the enforcement of existing laws are part of the discussion. NSQCD

325. U. S. Department of Health, Education, and Welfare. 1965. Proceedings: Conference in the matter of pollution of the navigable waters of the Detroit River and Lake Erie and their tributaries in the State of Michigan, June 15-18. U. S. Dept. Health, Education, and Welfare. Washington, D. C. Vol. 1-6. 1787 p.

Each industrial pollutant as well as the present treatment is described. The overall adequacy of treatment is detailed and various recommendations for cleaning up the river are discussed. The need for better water quality is stressed.

326. U. S. Department of Health, Education, and Welfare. 1965. Report on pollution of Lake Erie and its tributaries. Part 1: Lake Erie. U. S. Dept. Health, Education, and Welfare. Public Health Service. Div. Water Supply and Poll. Control. Washington, D. C. 50 p.

This technical report is based on studies made over the past two years under the supervision of the Department of Health, Education, and Welfare. Data obtained from other Federal, State, and local agencies were also used in the report. The report considers the quality characteristics of the waters as they exist today and trends in recent years. It evaluates the effects of waste discharges on water uses, and summarizes the principal problems and needed corrections.

327. U. S. Department of Health, Education, and Welfare. 1965. Report on pollution of Lake Erie and its tributaries. Part 2: Ohio, Indiana, and Michigan sources. U. S. Dept. Health, Education, and Welfare. Public Health Service. Div. Water Supply and Poll. Control. Washington, D. C. pp. 51-101.

The report considered the quality characteristics of the waters as they exist today and trends in recent years. It evaluates the effects of waste discharge on water use, and summarizes the principal problems and needed corrections. The various municipalities and industries which cause pollution are discussed as well as the recommendations for pollution abatement.

328. U. S. Department of Health, Education, and Welfare. 1965. Report on pollution of Lake Erie and its tributaries. Part 3: New York and Pennsylvania

sources. U. S. Dept. Health, Education, and Welfare. Public Health Service. Div. Water Supply and Poll. Control. Washington, D. C. pp. 103-122.

Pollution problems in three areas tributary to Lake Erie within Pennsylvania and New York are discussed in this section of the report. This report details water use, the source of wastes, the effects of pollution, and the recommended actions in each area.

329. U. S. Environmental Protection Agency. 1972. Proceedings of the First Federal Conference on the Great Lakes. U. S. E. P. A. Interagency Committee on Mar. Sci. and Eng. for the Federal Council for Sci. and Tech. Washington, D. C. 334 p.

The way in which Lake Erie relates to the general scheme of American resources is described. The economic needs of the areas around the Great Lakes are considered. The need to set maximum concentrations for chemicals is part of the discussion. NSQCD

330. U. S. Environmental Protection Agency. 1973. Bibliography of R and M research reports - socioeconomic environmental studies series. U. S. E. P. A. Office Res. and Monitoring. West Raleigh, N. C. EPA-R5-73-021. 81 p.

This bibliography identifies all current research reports recently published by the Office of Research and Monitoring and the Environmental Protection Agency.

331. U. S. Federal Water Pollution Control Administration. 1964. Water pollution control research and training grants. Index of 1962-1964 research grants, publications, and reports. U. S. Fed. Water Poll. Control Admin. Washington, D. C. 55 p.

The "Index of 1962-1964 Research Grant Publications and Reports" includes a total of 545 references to recent research supported by research grants. The value of this research information will be determined by the extent to which it is applied in the total research and development effort for controlling water pollution problems.

332. U. S. Federal Water Pollution Control Administration. 1967. Laboratory Manual. U. S. Fed. Water Poll. Control Admin. Washington, D. C. 49 p.

A surveillance program to evaluate the effectiveness of pollution control practices in local and lakewide situations has been instituted. The program includes 1) routine quarterly mid-lake sampling and bi-weekly sampling of the 13 major south shore tributaries, and 2) 30 stations in mid-lake. Surface, mid-depth and bottom water samples are taken in addition to sediment samples. Chemical and biological analyses are made on each. Tributaries are sampled, water only, for limited chemical analysis to monitor loading to Lake Erie of various constituents.

333. U. S. Federal Water Pollution Control Administration. 1968. Lake Erie environmental summary, 1963-1964. U. S. Fed. Water Poll. Control Admin. Great Lakes Region. Cleveland, Ohio. 170 p.

The sediment and water of the lake were studied for chemical constituents. Sixty sediment samples were analyzed for composition; 16 from the Western, 21 from the Central, and 23 from the Eastern Basins. Other samples were gathered throughout the lake and several harbors.

334. U. S. Federal Water Pollution Control Administration. 1968. Lake Erie report: A plan for water pollution control. U. S. Fed. Water Poll. Control Admin. Great Lakes Region. Cleveland, Ohio. 107 p.

The recommendations for a plan of action which combines the immediate and long range needs for clean water are reported. The pollution problem in its various forms is carefully detailed. The costs for industrial and municipal waste treatment plants are included.

335. U. S. Federal Water Pollution Control Administration. 1968. Lake Erie surveillance data summary, 1967-1968. Fed. Water Poll. Control Admin. Great Lakes Region. Cleveland, Ohio. 65 p.

This pamphlet is made up of tables and charts of survey data compiled from surveillance programs on Lake Erie water.

336. U. S. Federal Water Pollution Control Administration. 1968. Proceedings: Progress evaluation meetings, pollution of Lake Erie and its tributaries -

Indiana, Michigan, New York, Ohio, Pennsylvania. U. S. Fed. Water Poll. Control Admin. Cleveland, Ohio. 467 p.

A dialogue concerning pollution in Lake Erie produced an exchange of information between professionals and private citizens. Reports from the agencies which provide water surveillance and pollution abatement measures are included in the proceedings.

337. U. S. Geological Survey. 1970. Mercury in the environment. U. S. Geol. Surv. Washington, D.C. Professional Paper 713. 67 p.

The table on page 64 gives the mercury content of the water taken from the Maumee River.

338. U. S. News and World Report. 1965. Erie polluted: Ohio hollers uncle. U. S. News and World Rept. (April 8th). p. 55.

Pollution of Lake Erie waters results in zero dissolved oxygen as well as high concentrations of nitrogen and phosphorus. NSQCD

339. U. S. News and World Report. 1965. Filth in the Great Lakes: What can be done about it. (Interview). U. S. News and World Rept. (Dec.). pp. 58-61.

The topic presented herein was considered from the following points of view: (1) duration, (2) responsibility for the origin of pollution, and (3) returning the environment to a better balance. NSQCD

340. U. S. News and World Report. 1966. Lake Erie: Test case in the water-pollution battle. U. S. News and World Rept. (July 4). 61:12.

Nitrate and phosphate pollutants in Lake Erie waters are the object of political action. NSQCD

341. U. S. Office Water Resources Council. 1968. The nation's water resources. U. S. Water Resources Council. Great Lakes Region. Washington, D. C. pp. 6/3/1-6/3/11.

The nation's waters, their use, management, availability, and requirements are detailed in the publication.

342. U. S. Office of Water Resources Research. 1972. Chromium in water: A bibliography. U. S. Dept. Interior. Office of Water Resources Res. Washington, D. C. 126 p.

This publication is one of a series of planned bibliographies in water resources produced from the information base comprising only selected water resources abstracts.

343. U. S. Water Resources Scientific Information Center. 1972. Chromium in water: A bibliography. U. S. Office Water Resources Res. Washington, D. C. 126 p.

The bibliography is divided into sections as follows: (1) significant descriptor, (2) comprehensive, and (3) author index.

344. U. S. Water Resources Scientific Information Center. 1972. Lake Erie: A bibliography. U. S. Office Water Resources Res. Washington, D. C. 240 p.

This bibliography, containing 221 abstracted references, is one in a series of planned bibliographies in water resources produced from the information base comprising Selected Water Resources Abstracts. At the time of search for this information, the data base had 41,521 abstracts covering SWRA through May 15, 1972.

345. Upchurch, Sam B. 1972. Natural weathering and chemical loads in the Great Lakes. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. on Great Lakes Res. pp. 401-415.

Natural and cultural chemical loads can be estimated and differentiated for the Great Lakes Basin. Some modern loading estimates are obtained through use of U.S. and Canadian water quality data from populated drainage basins. Where insufficient data are available, loads are estimated by comparing the lithology of the surficial material and the material exposed at the pre-Pleistocene erosional surface to water quality and discharge data from streams with little cultural contamination. Extrapolation is made to unsampled basins of similar discharge and geology. Correlation studies of the Raquette and Maumee Rivers exemplify the response of chemical loads to temporal changes and to lithologic control and provide a basis for relating loading to weathering. Natural loads are based upon historical data.

Chemical constituents for which loads are estimated include: total dissolved solids (TDS), Cl^-, PO_4^{-3}, Ca^{+2} and SiO_2aq. The loading rates of Ca^{+2} and SiO_2 aq. reflect lithologic source materials, Ca^{+2} loading from carbonate terranes in the Erie and Ontario drainage basins and SiO_2 aq. loading in those basins where igneous and metamorphic rocks prevail. TDS, Cl^- and PO_4^{-3} reflect urban and agricultural loads which are important in Lakes Michigan, Erie and Ontario.

346. Uthe, J. F. and E. G. Bligh. 1971. Preliminary survey of heavy metal contamination of Canadian freshwater fish. J. Fish. Res. Bd. Canada. 28(5):786-788.

Heavy metal ion concentration in composite dressed northern pike, rainbow smelt, and yellow perch from Lake Erie are given in the results table.

347. Vallentyne, J. R., W. E. Johnson and A. J. Harris. 1970. A visual demonstration of the beneficial effects of sewage treatment for phosphate removal on particulate matter production in waters of Lake Erie and Ontario. J. Fish. Res. Bd. Canada. 27(8):1493-1496.

Filtered samples of raw sewage, biologically treated sewage, and sewage treated chemically for phosphate removal were added to unfiltered waters from Lakes Erie and Ontario, and particulate residues (PR) on Millipore filters photographed after incubation in light for 10 and 30 days. PR levels in the sewage-enriched flasks were least in the case of sewage treated for removal of phosphates. Addition of phosphate to the phosphate-depleted effluent increased its PR generating ability to that of raw and biologically treated sewage. The removal of phosphates from sewage wastes thus appears to eliminate their fertilizing effect.

348. Van Coevering, Jack. 1966. Tombstone for Lake Erie. Sports Afield. 153(5):66-67, 117-121.

A general article including mention of the industries which are polluting the Western Basin of Lake Erie. NSQCD

349. Van Meter, Harry D. and William F. Shepherd. 1967. Fishery picture changing in Lake Erie. N. Y. Conservationist. 22(2):2-3.

Oxygen as an essential chemical for fish habitat is discussed. NSQCD

350. Verber, James L. 1955. Bibliography of physical limnology, 1781-1954. Ohio Dept. Nat. Resources. Lake Erie Geol. Res. Program. Rept. Invest. 25. 57 p.

The Bibliography of Physical Limnology, 1781-1953, contains both a bibliography and subject index of the literature relating to physical limnology with special emphasis on the Great Lakes. The earliest paper listed was published in 1781. The most recent are those published in December, 1954.

Verduin, Jacob. - See: Kenneth Wood, No. 380.

351. Verduin, Jacob. 1957. Daytime variations in photosynthesis. Limnology and Oceanography. 2(4):333-336.

A study of CO_2-removal during July and August, 1954, under natural conditions in Western Lake Erie demonstrated a maximal rate during the hours of 0700-1000 (10 μmoles CO_2 absorbed per liter of water per hour), a reduced rate during the hours 1000-1600 (6 μmol/L/hr), a slightly negative rate during the daylight hours 1600-1900 (-1 μmole/L/hr), and night time negative rates similar to the day-time positive rates (-6 μmole/L/hr).

352. Verduin, Jacob. 1960. Phytoplankton communities of Western Lake Erie and the CO_2 and O_2 changes associated with them. Limnology and Oceanography. 5(4):372-380.

As a control for research on plant growth, dissolved oxygen, carbon dioxide and pH of the lake water were monitored.

353. Verduin, Jacob. 1962. Energy flow through biotic systems of Western Lake Erie. Great Lakes Basin. Am. Assoc. Adv. Sci. 71:107-121.

The levels of oxygen and carbon dioxide in water, as applicable to plant growth, is included within this paper.

354. Verduin, Jacob. 1963. Radioactivity of suspensoids in aquatic environments of Northwestern Ohio. Ohio J. Sci. 63(1):39-43.

Suspensoids in aquatic environments of northwestern Ohio contained between 12 to 23 times more radioactivity per gram than was present in the dissolved solids of the environment.

No positive correlation was observed between radioactivity of suspensoids and phytoplankton volume. The river phytoplankton volumes represented less than 1 percent of the suspensoids. Sphagnum plants from a bog showed higher concentration of radioactivity, per gram of ash, than was present in the suspensoids. When the concentration factors were computed as ratio of radioactivity per gram of fresh plant weight to the radioactivity per ml of environmental water a concentration factor of 550 was obtained. It is pointed out that similar concentration factors are obtained for non-radioactive portions of plant ash.

355. Verduin, Jacob. 1964. Changes in Western Lake Erie during the period 1948-1962. Verh. Internat. Verein. Limnol. 15:639-644.

The concentrations of the chemicals which can effect biological growth are mentioned in the report; CO_2, O_2, pH, nitrate and phosphate values are given.

356. Verduin, Jacob. 1964. Principles of primary productivity: Photosynthesis under completely natural conditions. In: Daniel F. Jackson (Ed.), Algae and Man. Proc. NATO Advanced Study Inst. Plenum Press. New York, N.Y. pp. 221-238.

A comparison of photosynthesis and respiration was made between two small ponds and Lake Erie.

357. Verduin, Jacob. 1969. Man's influence on Lake Erie. Ohio J. Sci. 69(2):65-70.

Investigations are now in progress, especially by the FWPCA, to learn whether Lake Erie is continuing to deteriorate, or whether it is in a more or less steady state. During a four year interval, soluble phosphates have increased by about 50%. Organic nitrogen increased about 30 percent in the same interval, suggesting that the observed phosphorus increase continues to enhance the production of organic matter. Total phosphorus in the sediment increased by about 40 percent, and ammonia nitrogen increased by a factor of 2.5, suggesting that there are increasing amounts of organic matter depositing on the bottom, where they are attacked by those decay organisms which generate ammonia.

358. Verduin, Jacob. 1970. Significance of phosphorus in water supplies. In: Wallrich and Smith (Eds.), Agriculture and Water Quality. Chapter 5. Pt. 2. pp. 63-71.

The author reviews the record of phosphorus use and the present levels of phosphorus discharge into the surface waters. Data on the relative contribution of urban sewage, phosphorus detergents, and agricultural drainage is given. A method for alleviating the problem of water pollution by percolation through a root zone formed by crop plants is presented.

359. Verduin, Jacob, Eloise E. Whitwer and Bruce C. Cowell. 1959. Maximal photosynthetic rates in nature. Science. 130(3370):268-269.

Environmental factors, carbon dioxide and pH, which can effect photosynthesis were reported and discussed.

360. Wagner, Frederick E. 1929. Chemical investigations of the Erie-Niagara watershed. In: A Biological Survey of the Erie-Niagara System. N. Y. Cons. Dept. Albany, N. Y. Supplement to the Eighteenth Ann. Rept. (1928) pp. 107-133.

Many of the streams have offered individual problems in the past, while the depletion of Lake Erie fishing has caused much discussion and conjecture regarding the possible contributory influences of the tributary streams, municipalities and industrial concerns which sewer into it. And so in the formulation of the chemical policy to be pursued it was decided that particular emphasis would be given to those streams of past concern, and to that part of Erie which might be affected by the influences mentioned.

Without regard to the particular water influences and arranged approximately in order of their prominence, the list of polluting substances includes municipal sewage, wastes from iron and steel works, textile, glue, tanning and chemical industries, canneries, milk plants, laundries, garbage and other wastes of lesser importance.

Waldron, A. C. - See: G. O. Schwab, et al, No. 291.

Walters, Lester J. - See: Thomas L. Kovacik, No. 194.

361. Walters, Lester J. Jr., Charles E. Herdendorf, L. James Charlesworth Jr., Hanns K. Anders, William B. Jackson, Edwin J. Skoch, David K. Webb, Thomas L. Kovacik and Charles S. Sikes. 1972. Mercury contamination and its relation to other physico-chemical parameters in the Western Basin of Lake

Erie. Internat. Assoc. Great Lakes Res. Proc. 15th Conf. on Great Lakes Res. pp. 306-316.

Preliminary results of a limnological cruise to collect water and sediment samples and to conduct field measurements of lake and atmospheric conditions in Western Lake Erie during an eleven-day period in July 1971 are presented. The objective of the survey was to determine the distribution of mercury in the water, sediment and benthic organisms of the Western Basin and its relationship to other physico-chemical properties of the water and sediment. Water samples, sediment cores and benthic organisms were taken at 63 stations, on a five-minute latitude-longitude grid, throughout the basin. Six other stations were concentrated at the mouth of the Detroit River.

Water flow patterns are illustrated by chloride, conductivity and temperature contours, showing the dominating influence of Detroit River flow into the Western Basin of Lake Erie. Three water masses enter Lake Erie at the mouth, a mid-channel flow low in temperature and mineralization and two contaminated edge flows. The mercury concentrations in the sediment reflect the same patterns. The highest values in Western Lake Erie occur under a stagnant water zone along the Michigan shore southwest of the river's mouth.

362. Walters, Lester J. Jr., Thomas L. Kovacik and Charles E. Herdendorf. 1974. Mercury occurrence in sediment cores from Western Lake Erie. Ohio J. Sci. 74(1):1-19.

The Detroit River is the major source of mercury contamination in the sediments of Western Lake Erie. Analyses of 63 sediment cores indicate that the mercury consists of two components: a high concentration (0.5 to 4.0 ppm of dry sediment) mercury-enriched surface zone, whose concentration decreases pseudo-exponentially with depth, and a low concentration (0.04 to 0.09 ppm of dry sediment) relatively constant-background zone. Mathematical modeling of the mercury concentration as a function of depth in these sediment cores and subsequent statistical analysis of the apparent constant-concentration levels reveals that two log-normal distributions are necessary to describe these observed constant concentrations. Any mercury concentration within the sediment in excess of the lower (natural) background level plus one standard deviation is defined as being due to pollution. Such calculations of the pollution component for these 63 cores serve as the basis for an

estimate of the total mercury that has been added through pollution sources. The mercury-pollution load for bottom sediments of Western Lake Erie is estimated to be 228 metric tons.

363. Walton, R. J. 1969. U. S. lake survey: Directory and project forecasts, the Great Lakes. Corps of Engineers. Lake Survey District. Detroit, Mich. 166 p. + appendicies.

Included in this report is the projected and continuing research activities of agencies conducting studies on all of the Great Lakes.

364. Weaver, Leo, Charles G. Gunnerson, Andrew W. Breidenbach and James J. Lichtenberg. 1965. Chlorinated hydrocarbon pesticides in major U. S. River Basins. U. S. Dept. Health, Education, and Welfare. Washington, D. C. Public Health Rept. 80(6):481-493.

Pesticides, like many other persistent materials such as certain radioactive wastes from nuclear installations and surfactants, can be expected to pollute the surface waters draining the various river basins. This study was based on analyses of the carbon chloroform extracts obtained by using carbon adsorption methods. Lake Erie and its tributary water analysis data is included in the results section.

Webb, David K. - See: Lester J. Walters Jr., et al, No. 361.

365. Webber, L. R. and D. E. Elrick. 1967. The soil and lake eutrophication. Internat. Assoc. Great Lakes Res. Proc. 10th Conf. on Great Lakes Res. pp. 404-412.

Nitrogen and phosphorus compounds in a soil are nutrients which are necessary for crop growth; however, sufficiently high concentration of these nutrients in water supplies can lead to accelerated eutrophication. Leaching and surface runoff are the two mechanisms by which these nutrients are transported from the soil to the water supplies.

The Grand River, Ontario was part of the region included in this study. Agricultural studies have shown that nitrogen compounds under normal soil conditions are oxidized to NO_3^--N, an anion which is mobile and free to move in some manner

associated with the soil water movement. An understanding of dispersion processes in porous materials is necessary in order to predict the concentration distribution in groundwater supplies. On the other hand, phosphorus compounds are fixed by normal soils and are therefore immobile within the soil. Both these compounds may be transported physically by surface runoff. Conflicting data showing lack of authoritative studies in this area are presented.

366. Webster, Edward J. 1967. An autoradiographic study of invertebrate uptake of DDT-Cl^{36}. Ohio J. Sci. 67(5):300-307.

On July 7, 1964, DDT-Cl^{36} was applied to a four-acre marsh in western Sandusky Bay, Ohio, to determine the fate of DDT in this natural environment. The plan included the collection of plants and animals at various post-application intervals for quantitative analysis. This research sought to locate autoradiographically DDT-Cl^{36} in tissues of leeches, amphipods, and copepods three months after their marsh habitat was treated with the amount of insecticide routinely used for mosquito control. Isotope DDT or its metabolite was found in cytoplasm of nerve cell bodies, gut mucosa, and vascular tissue of leeches. No isotope DDT was detected in the tissue of amphipods and copepods.

Weeks, Owen B. - See: David C. Chandler, No. 91.

367. Weeks, Owen B. 1944. A survey of the heterotrophic bacterial populations in the sediments of Western Lake Erie. Ph.D. Dissertation. Ohio State Univ. Columbus, Ohio. 63 p.

A survey of environmental factors, i.e. dissolved oxygen, carbon dioxide, bicarbonate and carbonate, pH and turbidity, which may effect bacterial populations, was included in the presentation of data.

368. Weiler, R. R. and V. K. Chawla. 1968. The chemical composition of Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 11th Conf. on Great Lakes Res. pp. 593-608.

The major and trace element concentrations during the summer and fall of 1967 in Lake Erie are presented. The distribution and concentration of ions in the main body of the lake and at the mouth of various rivers is discussed in the light of the 1967 and earlier information. A brief discussion of the

seasonal as well as long-term changes in the composition of the lake is given.

369. Weiler, R. R. and V. K. Chawla. 1969. Dissolved mineral quality of the Great Lakes waters. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. on Great Lakes Res. pp. 801-817.

In 1968 the Canada Centre for Inland Waters undertook a systematic monitoring of Lakes Ontario, Erie, Huron and Superior in a study of the major (Ca, Mg, Na, K, SO_4, Cl, HCO_3 and F) and trace (Zn, Cu, Pb, Fe, Ni, Cr, Mn and Sr) elements. The data gathered on major elements during the period July to November 1968 were examined and the results compared on a lake-wide basis with earlier compilations to appraise recent trends and changes in the composition of these waters. Lake-wide comparison of the trace element compositions of the Great Lakes waters is discussed.

370. West, Thomas C. and Gerald C. Allender. 1973. Selected analysis and monitoring of Lake Erie water quality. Annual Report. Erie County Health Dept. Erie, Pa. 60 p.

Analysis of the data from the water samples collected in the Pennsylvania region of Lake Erie during the 1973 season shows little difference in the water quality between points east and west of Erie, Pa. Comparison of studies during 1971 and 1973 indicate that water quality in the localized area of Presque Isle Bay is not improving; and for some parameters, although data is still too limited to establish trends, may be increasing. Levels of chemical and biological parameters are significantly higher in some areas. Sources of these pollutants are from the local community and are composed of industrial and residential wastes.

White, Merrie N. - See: Irene S. Pakkala, et al, No. 260, 261.

Whitwer, Eloise E. - See: Jacob Verduin, et al, No. 359.

371. Wildung, Raymond E. and Ronald L. Schmidt. 1973. Phosphorus release from lake sediments. U. S. Environmental Protection Agency. Office of Res. and Monitoring. Washington, D. C. 186 p.

Investigations were conducted to (1) characterize the major inorganic and organic forms of phosphorus in sediments, (2) determine the potential for release of phosphorus from

the sediment as influenced by water, sediment composition, and environmental parameters, and (3) establish the relationship between phosphorus release and algal growth.

Wilkens, R. A. - See: R. D. MacNish, et al, No. 219.

372. Williams, J. D. H. and Titiana Mayer. 1972. Effects of sediment diagenesis and regeneration of phosphorus with special reference to Lakes Erie and Ontario. In: H. E. Allen and J. R. Kramer (Eds.), Nutrients in Natural Waters. Wiley-Interscience. New York, N. Y. pp. 281-315.

Eutrophication reversal is discussed with consideration of possible influence of phosphorus regeneration from sediments on time required to reverse eutrophication, net phosphorus regeneration from sediment columns in idealized and actual situations, mechanisms for nutrient transfer from sediments, phosphorus forms, forms and amounts of phosphorus in Great Lakes sediment, and analysis of piston core samples. If inputs of phosphorus and nitrogen were reduced or increased to a new constant level, the concentrations of total phosphorus and nitrogen would asymptotically approach a new mean steady-state value. Provided oxic conditions are maintained, reduction in phosphorus input should result in more rapid attainment of a new mean steady-state phosphorus concentration than would be predicted if the role of sedimentation is ignored. The prevalent view is that, given a sufficient period of time and provided the rate of input of phosphorus is controlled sufficiently, even the most eutrophic lake will revert to an oligotrophic condition. If this is done, regeneration of a part of the excess phosphorus that accumulated in the sediments during the eutrophic conditions may extend the transition period and delay the attainment of oligotrophic conditions, but the ultimate trophic state of the lake should not be affected.

373. Williams, Roger C. 1929. Chemical studies of Lake Erie. In: A Biological Survey of the Erie-Niagara System. N. Y. Cons. Dept. Albany, N.Y. Supplement to the Eighteenth Ann. Rept. (1928) pp. 58-60.

The chemical investigation of Lake Erie was undertaken chiefly for the purpose of ascertaining the amount and extent of pollution from sewage and industrial wastes. Something of the normal chemical conditions in the lake was also determined as being of biological significance.

In order to carry out the chemical program the following analyses were made: Determination of free ammonia, albuminoid ammonia, and nitrates, free carbon dioxide, bicarbonate, carbonate, dissolved oxygen, hydrogen ion concentration and temperature.

Three chemical trips were made on the U. S. F. S. Shearwater, in July, August and September for the purpose of visiting the stations chosen as representative of that eastern portion of the lake included in the survey.

374. Williams, Roger C. 1929. Chemistry of pollution. In: Preliminary Report on the Cooperative Survey of Lake Erie, season of 1928. Bull. Buffalo Soc. Nat. Sci. 14(3):59-64.

As regards industrial pollution, whether acid or alkali, the reaction of the water to phenolphthalein and methyl orange and the pH showed no indication of any such pollution. It is known that wastes are being emptied into the lake from various sources. However, concentrated pollution from any source is made very dilute by mixing with an enormous quantity of water. In the open water normal oxidation processes change the suspended organic stuffs into soluble form. In the Buffalo region these wastes are being poured down the Niagara River in tremendous quantities and hence do not affect the lake waters.

In conclusion it ought to be pointed out that the analyses made and the conclusions drawn from the assembled data do not apply to the conditions that may exist in shallow water near shore. As regards the open lake water the analyses warrant the conclusion that the lake proper is normal and free from objectionable pollution.

375. Winchester, John W. 1970. Chemical equilibria of iodine in Great Lakes waters. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. on Great Lakes Res. pp. 137-140.

Iodine in Great Lakes waters, 1-3 μg/l, is uniformly distributed and near the content of natural rainfall without evidence of strong additional pollution sources. These concentrations, 20-60 times lower than in sea water, may present an environmental stress to organisms where iodine is an essential element. In the sea, iodine is utilized mainly as iodide by vertebrates and by brown and red algae. Although thermodynamically iodate is the most stable form in aerated water,

about half the total iodine is believed to exist as iodide, and a biochemical recycling of iodide in the marine biosphere is suggested. In fresh water, blue-green and green algae are not known to require iodine and may not therefore aid in keeping iodine in the reduced form. Therefore, iodide available to vertebrates in lake water, and especially to anadromous fish would have become adapted to live in lake water, may be in much shorter supply than suggested by the low concentration of total iodine alone.

Winklhofer, A. R. - See: J. O. Blanton, No. 39, 40.

376. Winner, John M. and James P. Hartt. 1969. A limnological study of River Canard, Essex County, Ontario. Internat. Assoc. Great Lakes Res. Proc. 12th Conf. on Great Lakes Res. pp. 103-115.

A number of chemical and biological characteristics of the river have been affected by the interreaction of organic pollution, agricultural enrichment, slow rate of discharge and high water temperatures. Oxygen levels are considerably lower than recommended water quality standards for fish, wildlife and other aquatic life. Low oxygen levels and high temperatures are factors that greatly influence plankton fluctuation. Chlorophyll a density and zooplankton populations showed a decline during mid summer when these factors were most evident. Illinois River plankton populations were observed to be reduced when temperatures were above 80°F. River Canard temperatures exceeded 80°F on a number of occasions. Free carbon dioxide as well as sulfate levels can be attributed in part to pollution factors.

Wong, P. T. S. - See: D. Liu, et al, No. 213.

377. Wood, Kenneth G. 1963. The bottom fauna of Western Lake Erie. Univ. Mich. Great Lakes Res. Div. Proc. 6th Conf. Pub. 10:258-265.

During 1951-52, 204 drag-dredgings were taken from Western Lake Erie. Collections were analysed for type of sediment, organic matter content and macroscopic bottom fauna. The distribution of organic matter in the sediments was determined by a chromic acid titration method and expressed as a percentage of the oven-dried weight of the sediment. The Western Basin was found to be divisible into three main north-south zones of organic matter each about 9 miles wide. The zone of highest organic matter (3.7 to 5.6%) comprised an area of 170 square miles between Colchester, Ontario, and

West Sister Island. A zone of intermediate organic matter (3.0 to 3.7%) was interposed between the highly organic area and the lowly organic sands and gravels in the vicinity of Pelee and Kelley's Islands.

The sediments were also analysed by the Bouyoucos soil hydrometer test and by sieving with standard screens. Data from these tests were combined to calculate the phi median ($-\log_2$ [average particle size in mm]) and the Trask sorting factor ($\log_2$ [phi quartile deviation]) for each sample. It was assumed that material remaining in suspension after 2 hr had an average particle size of 2.76 micra.

The coefficient of correlation between organic content of the sediments and phi median value of 145 samples was 0.89. At constant sorting factor the correlation was 0.96. Thus the more homogenous and clayey sediments were the more highly organic.

378. Wood, Kenneth G. 1968. Pollution and Lake Erie. Bios. 39(3):103-110.

The paper discusses the effects of pollution on the organisms and plants living in an aquatic environment.

379. Wood, Kenneth G. 1970. Carbonate equilibria in Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. on Great Lakes Res. pp. 744-750.

The relationship between total CO_2, total alkalinity and pH is shown for dilute Na_2CO_3 solutions, and for Lake Erie. The Na_2CO_3 solutions behave in accord with existing theory, using $pK_1' = 6.4$ and $pK_2' = 10.2$ at 25°C. However Lake Erie does not show the properties of a dilute Na_2CO_3 solution at alkaline pH levels, as it contains less CO_2 than predicted at pH 8.3 to 9.5.

380. Wood, Kenneth G. and Jacob Verduin. 1971. Correlation between CO_2 and O_2 concentration in Lake Erie, U. S. A. Arch. Hydrobiol. 71(1):1-16.

Oxygen concentration was correlated with total CO_2 concentration, both variables reported as the µmoles/l difference from air equilibrium. CO_2 deficits were not associated with corresponding O_2 supersaturation, but O_2 deficits were associated with corresponding CO_2 excess, mole for mole. However, the hypolimnion of the Central Basin of Lake Erie showed as much as 30 percent greater CO_2 excess than O_2

deficit during late August, when dissolved O_2 values approached zero. These values suggest a significant anaerobic respiration contribution. New equations are provided for studies of carbonate equilibria. The differential titration method for estimation of biological productivity is discussed.

Youngs, William D. - See: Raymond J. Lovett, et al, No. 214.

Zaebst, K. - See: R. M. Pfister, et al, No. 264.

381. Zubkoff, Paul L. and Walter E. Carey. 1970. Neutron activation analysis of sediments in Western Lake Erie. Internat. Assoc. Great Lakes Res. Proc. 13th Conf. on Great Lakes Res. pp. 319-325.

Sediment cores, 15 cm in depth, were obtained in February, May, and August of 1969 from a location (long. 82°50'50"W; lat. 41°41'30"N) which has been under biological surveillance for more than 15 years. The centers of 1 cm lateral sections of these cores were washed free of interstitial water and subjected to a 2.0×10^{11} neutron $cm^{-2}sec^{-1}$ flux in the Ohio State University Research Reactor.

Analysis of the resulting gamma-ray spectra, obtained with a NaI(Tl) crystal, indicate a uniform concentration [μg/g] of Al (61,000), V (500), Mn (478), Na (3,144), La (8.7), Cr (319), and Sc (5.1). These data indicate that V and Cr are present in quantities at least three times greater than those normally reported for soils.

382. Zweig, Gunter, John H. Nair III and Billy Compton. 1967. A study of fat and oil pollution of New York State waters. N. Y. Dept. Health. Albany, N. Y. Res. Rept. 16. 90 p.

This report contains sections detailing the methods for identification of the various constituents of oil pollution. Section II deals with pollution on the Niagara region, specifically Smokes Creek and a drainage ditch from Bethlehem Steel Company. The analysis suggests that the floating oil and grease is mainly petroleum in origin.

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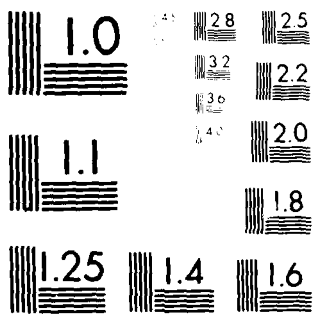

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VII. ABBREVIATIONS

Acad.	Academy
Admin.	Administration
Adv.	Advancement
Agric.	Agriculture
Am.	American
Ann.	Annual
ASChE	American Society of Chemical Engineers
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
Assoc.	Association
Bd.	Board
BECPL	Buffalo and Erie County Public Library
Biol.	Biology, Biological
BL	Bell Library - State University N.Y. at Buffalo
Bot.	Botany
BU	Butler Library - New York State University College at Buffalo
Bull.	Bulletin
CA	Calspan Corporation Library
Calif.	California
CCIW	Canada Centre for Inland Waters Library
CE	Corp of Engineers - Buffalo District Library
Chem	Chemistry, Chemical
Circ.	Circular
Co.	Company
Comm.	Commission
Conf.	Conference
Conn.	Connecticut
Cons.	Conservation
Contrib.	Contribution
Cult.	Cultural, Culturist
Dept.	Department
Dev.	Development
Div.	Division
Ecol.	Ecological

Ed.	Editor
Eng.	Engineering
Engr.	Engineer
Env.	Environment, Environmental
E.P.A.	Environmental Protection Agency
Exp.	Experiment, Experimental
Fed.	Federal
Fish.	Fishery
Gaz.	Gazette
Geog.	Geographic, Geographical Geography
Geol.	Geologic, Geological Geology
Geophys.	Geophysical
GLL	Great Lakes Laboratory
I.J.C.	International Joint Commission
Ill.	Illinois
Inc.	Incorporated
Ind.	Industrial
Info.	Information
Inst.	Institute
Internat.	International
Invest.	Investigation
J.	Journal
Lab.	Laboratory
LO	Lockwood Library - State University New York at Buffalo
Mag.	Magazine
Man.	Manitoba
Mar.	Marine
Mass.	Massachussetts
Memo.	Memorandum
Meteor.	Meteorological, Meteorology
Mich.	Michigan
Micro.	Microscopical
Mid.	Midland
Mon.	Monthly
Mono.	Monographs
Nat.	Natural
No.	Number
NOAA	National Oceanic and Atmospheric Administration
NSQCD	No Specific Quantitative Chemical Data
N.Y.	New York
Okla.	Oklahoma

Ont.	Ontario
p.	Page
pp.	Pages (inclusive)
___p.	Pages (total in report)
Pa.	Pennsylvania
Petrol.	Petrology
Phil.	Philosophical
Phyc.	Phycology
Poll.	Pollution
Pop.	Popular
Prelim.	Preliminary
Proc.	Proceedings
Prog.	Progress, Progressive
Pt.	Part
Pub.	Publication
Rept.	Report
Res.	Research
Rev.	Review
Sci.	Science, Scientific
SE	Science and Engineering Library - State University New York at Buffalo
Sec.	Section
Sed.	Sedimentary
Ser.	Series
SM	Buffalo Museum Science Research Library
Soc.	Society
Spec.	Special
Surv.	Survey
Sym.	Symposium
Tech.	Technical, Technology
Trans.	Transactions
UB	State University New York at Buffalo
Univ.	University
U.S.	United States
Vol.	Volume
Wea.	Weather
Wisc.	Wisconsin

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